# Novalis's idea of "Experimentalphilosophie" : a study of Romantic science in its context.

Henderson, Fergus Roy

# Novalis's idea of "Experimentalphilosophie". A study of Romantic science in its context.

Fergus Roy Henderson

A thesis submitted for the degree of
Doctor of Philosophy

Queen Mary and Westfield College
University of London

1995

# Abstract


This thesis seeks to examine Novalis's philosophy of practical knowledge and to position it within the context of the work of other Romantic natural philosophers and some aspects of contemporary science. His views on Ritter's galvanism and the latter's significance for his thought in general are treated here for the first time in full.

Contrary to most previous views, it is argued that a major part of Novalis's outlook stems from his concept of practical knowledge and his reflection over the term "experiment", which proves to be an extremely complex and central idea in his thought. It is shown how this philosophy of his finds most explicit expression in the idea of a symbolic notation or a "phenomenal" calculus. These notions merge in Novalis's idea of productive "Plastisirung". Particular attention is paid to the symbolic use of phosphorus in the pneumatic debate and Ritter's galvanic interpretation of the nerve. Beyond contemporary science, it is further shown how broad an historical base Novalis channels into his notion of practical knowledge. This should lead to a clearer understanding of Novalis's position within Romantic natural philosophy, his debt to tradition, and his originality.

In the light of these findings, it is argued that Novalis's concern for practical knowledge provides the basis for a possible form of consensus in his thought. It is shown that there is an increasing tendency in his writings away from a programme for classifying knowledge in general towards the idea of individual knowledge and the case study, as is exemplified in his reception of Ritter's work. It is also advanced that Novalis's notion of practical knowledge is a significant methodological statement of early Romantic science, which also puts a new perspective on thinkers such as Goethe, Humboldt, Schelling and Ritter.

# Contents

Chapter One

Novalis and the tradition of "experiment"



Chapter Two

The emergence of Novalis's notion of "experiment".

1. The "experiment".



2. The experimenter.

Chapter Three

Unifying theory
The possibility of natural philosophical productivity as a programme for classifying the sciences.

## Chapter four

## Unifying practice
The probability of individual philosophical productivity as a programme for treating the sciences in terms of practical knowledge.



## Conclusion

## Unifying practice: a perspective for intellectual history.

# Illustrations

## Acknowledgements

Thanks go first and foremost to my wife for her enduring patience, and further to our parents. I also owe very much to my supervisor, Professor Jeremy Adler, for his guidance, comments and assistance throughout the progress of the work, and for his openness and willingness to discuss any topics that were raised.
I am grateful to Queen Mary and Westfield College for awarding me a Postgraduate Studentship, and to the University of London for a Central Research Fund grant.
Thanks go to Wolf Reinhardt for his kind help, and also Philip Wilson and Dr. Christopher Lawrence. Particular thanks go Dr. Bernhard Fritscher and Paul Ziche for many stimulating conversations. Special thanks go to Hermann Röder, who made the final phase of writing up this dissertation possible.

# Abbreviations and a note on quotations

Abbreviations have been used for the following works. Their number in the bibliography is indicated in brackets.

N =

*Schriften.* Die Werke Friedrich von Hardenbergs, eds. Paul Kluckhohn and Richard Samuel. Zweite, nach den Handschriften ergänzte, erweiterte und verbesserte Auflage in vier Bänden und einem Begleitband, 5 vols., Stuttgart; Berlin; Köln; Mainz: Kohlhammer, 1960-1988.
Vol.1. Das dichterische Werk, eds. Paul Kluckhohn and Richard Samuel together with Heinz Ritter and Gerhard Schulz, 1960; 3rd enlarged and revised edition, 1977.
Vol.2. Das philosophische Werk I, eds. Richard Samuel, Hans-Joachim Mähl, and Gerhard Schulz, 1965; 3rd edition, 1981.
Vol.3. Das philosophische Werk II, eds. Richard Samuel, Hans-Joachim Mähl, and Gerhard Schulz, 1968; 3rd edition 1983.
Vol.4. Tagebücher, Briefwechsel, Zeitgenössische Zeugnisse, eds. Richard Samuel, Hans-Joachim Mähl, and Gerhard Schulz, 1975.
Vol. 5. Materialien und Register, eds. Hans-Joachim Mähl and Richard Samuel; index by Hermann Knebel, 1988.

R =

Ritter, Johann Wilhelm: *Beweis, daß ein beständiger Galvanismus den Lebensproceß in dem Thierreich begleite*, Weimar, 1798. (92)

Primary sources are cited as they stand; no attention is drawn to any anomalies. Sources are given in round brackets after quotations. The first number, given in italics, denotes the number of the work in the bibliography; the following numbers to the volumes and pages. Volume numbers are always given in arabic numerals. If a work has parts and volumes, then the part is given first in Roman numerals. Occasionally italicized words have been inserted in square brackets into quotations for the ease of comprehension.
When German words or phrases are given in running text the endings have been silently modified to integrate them into the sentence.

*When in the investigation of any nature the understanding is so balanced as to be uncertain to which of two or more natures the cause of the nature in question should be assigned, on account of the frequent and ordinary concurrence of many natures, instances of the Fingerpost show the union of one of these natures with the nature in question to be sure and indissoluble, of the other to be varied and separable; and thus the question is decided, and the former nature is admitted as the cause, while the latter is dismissed and rejected. Such instances afford very great light, and are of high authority, the course of interpretation sometimes ending in them and being completed.*

Bacon (7, XXXVI).

Am Ende *scheint alles Nachdenken auf ächtes Experimentiren zu führen - und die sog[enannte] Vernunftlehre - die Nothwendigkeit, Methode, etc. des Experimentirens und Lebens, als eines beständigen Experimentirens zu enthalten und beweisen.*

Novalis (*N*, 3, 402).

*Aber was ist denn ein thierischer Theil, und was der Körper, zu dem er gehörte? Es ist ein System in einander wirkender Kräfte ... Aber jenes System ist selbst das was es ist, nicht durch sich allein, nur in sofern ist es dieß, als es Theil ist eines höheren dynamischen, des vollkommensten aber organischen System, der Natur, und daß es überhaupt ist, verdankt es selbst der Natur. Sie ist das Ideal aller organischen Wesen, absolut in sich beschlossen, ewig in sich, und ewig das was sie ist, bleibend, bleibend* - Natur.

Ritter (R, 170-171).

*Man kann Reitz oder Thätigkeit durch bloße Veränderung der Kettenglieder hervorbringen. Alles ist Glied einer Kette. Jedes neue Glied veranlaßt* Repraesentationen *in den andern Gliedern - dadurch Thätigkeit.*

Novalis (*N*, 3, 612).

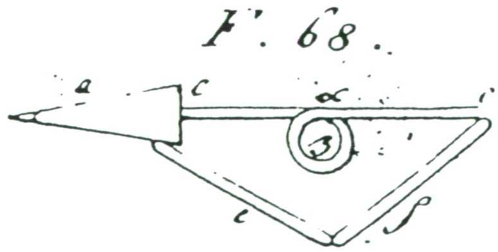



*Fig.1. Ritter's sixty-eighth galvanic figure (Beweis, 1798).*

# Introduction

## Intellectual history and early Romantic natural philosophy

*1. Current perspectives of Novalis scholarship for intellectual history: ethics, pluralism, immanent transcendence, narrative construction and "experiment".*
*2. Premises and methodology.*
*3. Aspects of genre in early Romantic natural philosophy.*
*4. Novalis's notion of "experiment" and the issues of practice in the context of early Romantic natural philosophy.*
*5. Conclusion on methodology and premises. Summary of the issues of genre and practice for early Romantic natural philosophy.*
*6. Overview of Novalis scholarship relating to the context of the sciences, philosophy and aesthetics.*
*7. Plan of work.*

## *1. Current perspectives of Novalis scholarship for intellectual history: ethics, pluralism, immanent transcendence, narrative construction and "experiment".*

Before I define the methodological premises of this thesis in greater detail, as concerns current debate over literature and science, and scientific historiography (in section 2), I here wish first to offer the reader some initial perspective on Novalis scholarship's relationship to intellectual history. This will, I hope, provide the reader with a cogent and succinct introduction to Novalis's thought in terms of current debate in intellectual history, as well as to this work's concern for Novalis's notion of "experiment". Novalis's notion of "experiment" cannot be treated in some philosophical vacuum within his works. It is necessarily involved in the very centre and heat of the Novalis debate. The notion of "experiment" fits into the present discussion in Novalis scholarship surrounding various forms of postmodernism and the relevance of German Idealism to postmodernism.

An outline of Novalis's notion of "experiment" within the context of his writings and life must first be given before embarking on this discussion of Novalis scholarship's stance to intellectual history and the positioning of this thesis therein. This work attempts to account for the views of the mature Novalis (1798-1800) as they appear in his notion of "experiment" and in his "experimental philosophy" in his theoretical and scientific writings. The term "experiment" is little used by Novalis before his arrival at the Freiberger Bergakademie, and becomes increasingly important for his notion of knowledge from the *Freiberger naturwissenschaftliche Studien* and *Das allgemeine Brouillon* onwards.[1] He began work on the *Freiberger naturwissenschaftliche Studien* in June 1798, and on *Das allgemeine Brouillon* in September of the same year. Both note-books were begun, then, some time after his arrival in Freiberg in December 1797. His notion of "experiment" was undoubtedly influenced by his time at Freiberg and is a direct response to his scientific studies. Novalis's new interest in the sciences does not by any means amount to an explicit dismissal of his previous philosophically oriented studies in the favour of scientific "evidence". Rather, his scientific studies enabled him to develop the other half of his outlook on knowledge. What he had already gained from German Idealism about the primacy of the subject, and what he had learned of the Neoplatonic tradition, mainly from Hemsterhuis (1721-1790), was now complemented by concrete knowledge of actual scientific phenomena. All of these currents together gave Novalis the material for his own model of natural philosophy.

His remarks soon after his arrival at Freiberg, in a letter of 26 December 1797, show just how his scientific studies were broadening his horizons, they afforded him a new approach, and indeed a better understanding of knowledge in general:

Die Philosophie verstehe ich immer besser, je tiefer ich in die übrigen Wissenschaften eindringe (*N*, 4, 242).

Practical knowledge of the sciences reinvigorated his grasp of philosophy. Clearly, the influence of the empirically-minded Werner (1749-1817) had a role to play in the formation of the maturer Novalis's interests, both through his personality and through his historical and philosophical attitude to the sciences.[2] Kant's (1724 - 1804) and Schelling's (1775-1854) notion of dynamism and the latter's natural philosophy were also key points of influence on Novalis's natural philosophy. As already indicated, a major influence, too, was Ritter's (1776-1810) work on galvanism, which covered a broad area including chemistry, "Physik" and physiology. Ritter's work also enriched Novalis's views on organization and excitability, that had already been fired by his reading of Brown in the previous year.[3] Novalis's physical and chemical studies at Freiberg would also have accentuated his interest, likewise inaugurated in the previous year, in affinity and its Neoplatonic counterpart "Sympathie". Novalis had originally taken this idea over for his own project from Hemsterhuis, and now it was to be deepened and refined by a new empirical dimension. In addition, his reading of Goethe's (1749-1832) scientific works, revealed in the perceptive essay *Über Goethe* of August and September 1798, gave further credence to his views that the roles of the artist and the scientist could be combined in a method of inquiry. Numerous sources in fact come together in a highly productive way. Herder's (1744-1803) *Plastik*, which he read and made notes on at the same time as writing the essay on Goethe, gave him useful conceptual tools with which he could then confront aspects of Kant's epistemology in the *Freiberger naturwissenschaftliche Studien*. As his horizons broadened, Novalis's notion of inquiry, his experience-oriented notion of knowledge, finally became explicit towards the end of *Das allgemeine Brouillon*. This was when he read of Plotinos (205-270), who afforded him both a model of inquiry and of Nature. This enhanced the Neoplatonic stance he had assumed after studying Hemsterhuis. Both in the way of epistemology and regarding natural philosophy, Plotinos gave Novalis a highly concrete intellectual edifice. The central importance of Plotinos for Novalis lies in the former's philosophical style, which Novalis interpreted as a form of "thätiger Empirismus". Moreover, Plotinos puts forward an explanation of just how the cardinal force of "Sympathie" came about through the reflection of the "One" upon itself, and how in turn man's act of reflection is also caused by the universal force of "Sympathie". Besides, Plotinos's hypostases gave Novalis a model of the universe which suited his notions of organization and a creative Nature.

The notion of "experiment" and the associated concepts of practical knowledge, knowledge formation and the aesthetics of scientific productivity have not been dealt with fully in Novalis scholarship. The sciences have been treated in Novalis's works, but this has mostly taken place in respect of medicine and mathematics. Chemistry and "Physik" still remain relatively uncharted areas of Novalis's thought (*354*, 152, 164). This work's uncovering of Novalis's view on phosphorus in the pneumatic debate and Novalis's relationship to Ritter aims to contribute to some extent to filling this lacuna in Novalis scholarship. However, this is not the central issue here. The neglect of the issues of "experiment", practical knowledge and the sciences other than medicine, and the predominant concentration of Novalis scholarship on literary, moral and political aspects of Novalis's works is somewhat surprising given the Romantic concerns for natural philosophy and reflection about the limits of knowledge. Naturally, Romantic science has itself suffered neglect, but, even given this neglect, there is much in Novalis's writings which points to the cardinal importance of the sciences, their methodologies and their development for his thought. It is particularly in the area of methodology that this work wishes to assert the value of Novalis's scientific writings. Thus, as will be discussed, this work goes beyond tackling specific doctrines, e.g. of natural philosophy, to the study of methodologies. The end of the eighteenth century was an age of reflection and it was the point when the institutionalized scientific disciplines, as we know them today, were being formed: it is therefore highly probable, as the main thrust of this work suggests, that a key concern of the Romantics - who, as Ziolkowski has shown, were deeply involved in institutions (*303*) - lay in ascertaining proper methodologies of knowledge, particularly with respect to the sciences. This context is stressed by the editors of *Romanticism and the sciences*, who recognize that the period is important for the foundation of the sciences:

Indeed two "Scientific Revolutions" are now commonly recognized - a first revolution around the turn of the sixteenth century, in which new mathematically and experimentally oriented branches of natural philosophy were created, and a second revolution around the turn of eighteenth century, in which was formed the federation of disciplines that we call "science" (*159*, 1).

Important too, as the editors further comment, is that it was a period of great self-understanding:

The second revolution, however, is marked by enterprises in individual and cultural self-understanding that are both more radical and more explicit. To start with we may note that the major critical movements of the period which affect the arts and sciences are all enterprises in self-understanding. This is manifestly so in the critical philosophies which explore the scope and limits of human knowledge on the basis of an examination of the nature and powers of the human cognitive faculties - the philosophies of Hume, Kant and Johann Heinrich Lambert, for example (*159*, 1-2).

It is perhaps worth remembering that Novalis's encyclopaedic interest is not simply the result of his "Genie", but reflect the concerns of this second revolution, and that his overt interest in encyclopaedism and in the subject reflects the period's own emphasis on self-understanding.

Importantly, Novalis had substantial knowledge of contemporary scientific thought and inquiry. It is true that his method does not come up to the strictures of a mathematical paradigm, but that was not his intention, and in his theory of practice Novalis was endeavouring to show that analysis or logic were not enough for inquiry, and that knowledge involved much more than logic. Novalis's model of inquiry is, then, correspondingly broad, but often sufficiently practice-oriented to remain concrete; indeed, he believed it had to be so, for the establishment of truth to him relied above all on "Experimentiren". He remarks, for example, in a key fragment in the *Das allgemeine Brouillon*, how the commonly used form of logic, the principle of contradiction, had, in his view, to be employed in conjunction with "ein andres Vermögen" in an "experimental method", whereby both logic and man's other faculties would complement one another. Such a method would approximate to a type of "thought-calculus", gradually reaching towards truth: at the very least, it would result in a better form of theory, since the results would have been put through a process of "experimentation". The fruits of Novalis's reading and his quest for a reliable method can be seen in the following remark from the *Das allgemeine Brouillon*:

Sollte es sich bestätigen, daß der Satz des Widerspruchs der Grundsatz des Denkvermögens, der *Oberste* der *Logik*, sey, so wäre dies nur eine Indication , daß wir mit der Logik *allein* nicht viel ausrichten könnten, daß das Denkverm[ögen] *allein* keinen (großen) Nutzen gewähre - sondern, daß wir noch ein andres Vermögen und seine Theorie aufsuchen müßten, die als dem Denkvermögen und d[er] Logik entgegengesezt und *allein* eben so nutzlos, als diese, in Verbindung mit diesen gesezt werden müßten, um daraus ein zusammengeseztes Vermögen - und zusammengesezte, sich gegenseitig complettirende Theorieen und Handl[ungen] und Resultate zu erlangen und so fort. *Am Ende* scheint alles Nachdenken auf ächtes Experimentiren zu führen - und die sog[enannte] Vernunftlehre - die Nothwendigkeit, Methode, etc. des Experimentirens und *Lebens*, als eines beständigen Experimentirens zu enthalten und beweisen (*N*, 3, 402).

Novalis here affirms the necessity of combining contrary approaches, and concludes by asserting his fundamental belief in "experiment". It will be shown how Novalis seeks to combine the ontological premises of scientific logic with those of aesthetics. Novalis sees that science obviously leads to progress, but this progression should be harnessed to aesthetics, and ultimately, a higher notion of natural philosophy.

To turn now to the ramifications of Novalis scholarship for intellectual history: these are best analyzed in a discussion which revolves around von Molnár's, Neubauer's, Frank's, Uerlings's and this present work's stances to Novalis. All these critics can be seen then as voices productively interpenetrating to afford a better understanding of Novalis. As in the following sections of the introduction, I will deliberately be letting various stances interplay in order to check areas of genuine complementarity and to gain access to intermethodological enhancement.

Von Molnár and Neubauer have put Novalis into the postmodernist context in different ways (*336; 340*). In his essay of 1989 von Molnár sums up the concern of his major work of 1987 which was to show the self-reflexivity of Novalis's thought (*335*). Von Molnár does not make links to practical knowledge in the sense of scientific practice and knowledge formation. Practical knowledge remains explicitly at the ethical level, and not at the other practical "ethical" level of knowledge formation:

> Effectively, the interrelatedness of science, language, and human conduct arises for Novalis within a self-reflexive continuum where the sciences seem to refer to nature but actually point to the question of intersubjective valence, acts of communication seem to refer to concepts but actually refer them to the intersubjective context of human communality, communal organization ..." (*336*, 124-125).

Von Molnár sees Novalis's thought in essence as a project which seeks to poeticize all realms of knowledge by treating them in terms of poetry and meaning creation (*336*, 125-6). This is a view which importantly illustrates just how moral and practically concerned Novalis's aesthetics are. However, do Novalis's views have to be seen in terms of a communicative social construct, even given that von Molnár avoids the common ontological relativism of sociologists by referring to a moral regulative principle for the members of a community? Novalis's relationship to Ritter shows precisely the reversal of such a view, for there the epistemology of the individual's scientific discovery leads to a form of consensus. In Ritter's work "acts of communication" refer first to the intersubjective context of the individual inquirer and the phenomena under investigation. The ethical element of the early Romantics' natural philosophy lies in the way they pay respect to Nature's own subjectivity and purposiveness, and also in their experience-based (as opposed to theoretically based) methodologies. In a second step one may begin to speak of the way in which "acts of communication" refer to "the intersubjective context of human communality". Novalis's view of phosphorus in the pneumatic debate does, however, come closer to von Molnár's view of a moral social construct, since Novalis appears primarily to be underlining the social uses of phosphorus as consensual term or metaphor for the activities in the pneumatic debate. Thus Novalis has both social and epistemological elements in his thought on the sciences, although I would argue in general for the primacy of epistemological elements. Another case of consensuality with sociological, ethical and epistemological elements in Romantic natural philosophy that is worth mentioning in this context is, as Sepper intimates, to be found in Goethe. Goethe sees the need for scientists to be continually aware of the phenomenal foundations or core of their subject matter. Goethe envisages an ethical element in the idea that scientists must be able to work together and discuss matters at this basic level of the core of their discipline before moving onto speculative work. The epistemological element lies in the fact that agreement must be arrived at over foundational issues before progressing into deeper layers of theory where the danger lurks that "reality can slide ever further away, from appearance to substructure to sub-substructure". Sepper remarks further:

For Goethe the core of a science is its subject matter, comprehensively worked out from everyday experience and amplified by technical praxis. If scientists do not have a clear understanding of this core, then they really do not know what their science is about. Although science does not stop at this core, it begins there and also eventually returns. ... it is ... imperative that scientists cooperate at this basic level, which means they have to share results, offer comment and criticism ... In doing so they will fulfill one of Goethe's chief hopes, that scientists will devote careful attention to the groundwork and purview of their science as a basis for more highly speculative work. If these conditions are met, the science can be understood as single and continuous, despite changes over time, because the constant reference to phenomenal foundations, even in cases of amendment, returns the science to its point of origin (*276*, 188).

There is, however, a further aspect to von Molnár's views. Neubauer points out that although von Molnár's work pays "attention to Novalis' concern with the absolute and his position in the history of mystical thinking", von Molnár's prime concern is to show that there is in Novalis's work "an intersubjectivity that is founded on the subject and the community of subjects, and not on some metaphysical entity" (*340*, 133). Neubauer then goes on to alert our attention to the fact that, even given von Molnár's sociological streaks, his notions of the "normative regulative principle" and the "ideal community of mankind" do have absolute, metaphysical elements. These notions, as Neubauer remarks when referring to a passage in von Molnár's work of 1987 (*335*, 201), leave a gap between actual and ideal practice, and stress the ideal of poeticizing (the consensus of poetry) to the detriment of the reality of Novalis's own practice:

Notice that in this explanation the intersubjective force of science comes not from some kind of agreement between signifier and signified (or systems thereof) but from an agreement between the communicants that is demanded of them by a "normative regulative principle". ... This leaves, as in Kant's ethics, a gaping hole between actual and ideal practice ... One may judge action by the standard of the categorical imperative but one cannot assume that it is *de facto* the standard that people use in deciding on action ... To what extent Novalis was aware of this gap between what is and what ought to be, to what extent he thought it possible to proceed towards consensus of

> dialogical clashes between irreconcilable opposites, is a matter on which there may be legitimate disagreement. But we must admit that all his notes, his fragments, his poetic works enact and juxtapose different voices or discourses that do not merge - no matter how much he wished consensus as an ideal. The rhetoric of this ideal should not overshadow the reality of his writerly practice (*340*, 136-137).

Neubauer is wise here to remind us of the passivity and pluralism in Novalis's works. Equally, as Neubauer points out, as fragmentary as some aspects of Novalis's works are, there is a definite epistemological element. Neubauer does allow for "legitimate disagreement" here. He does himself refer to the "metaphysical anchor" in Novalis's notion of language. According to Neubauer, Novalis's notion of language is not entirely deconstructionist free-play, but falls into a more differentiated category of deconstructionism, where language is seen as a "nostalgic play with signs of a structure that has lost its center" (*340*, 133, 139 fn.4). A more direct anchor - which need not necessarily be interpreted metaphysically - is found, I think, in Herder's *Plastik*. Another view on language, that of Manfred Frank, will be discussed below. However, I side with Neubauer in his defence of Novalis's pluralism against von Molnár's view of Novalis, which tends towards notions of absolute morality. None the less, Novalis cannot be seen as a fully-fledged pluralist, which is the stance Neubauer takes up more emphatically at the end of his essay. There are instances in Novalis's thought where open-ended pluralism is combined with cognitive gain and moral elements. The concrete example of phosphorus can be seen, for example as an instance of ethics in natural philosophy. Phosphorus was a readily employable "moral" scientific principle that is embedded in the practice of the science of the time. This principle is not as highly positioned as a strictly ethical principle. It is not absolute, but transcendent in contemporary scientific practice. It is, admittedly, not employable by von Molnár's "ideal community of mankind", but at least by the scientific community. This pattern in Novalis's thought - of the transcendent as opposed to the absolute - is also found in his views on eschatology and history, as Uerlings argues in his description of Novalis's utopia as a "narrative Konstruktion einer erhofften Tendenz" (*354*, 609-613).

Neubauer's view of Novalis's pluralism has however elements which are highly congenial to, and are reflected in this present work, for Neubauer stresses the questioning and experimental nature of Novalis's approach to inquiry (*340*, 137).

Neubauer does seem to be suggesting a type of progressive pluralism which approaches inquiry from as many vantage points as possible. For Neubauer it is Novalis's notion of experiment that staves off any attempts at over-hasty absolute consensus (*340*, 136). Thus, in a different way to this present work, Neubauer arrives at similar conclusions over the "experimental", more practical and non-absolute stance of Novalis to inquiry.

There are further aspects of modern philosophy which relate to Neubauer's work. Neubauer sees two strands in Novalis's thought - that of pluralism which "anticipates Paul Feyerabend's critique of methodological monism", and, secondly, a strand which he is correctly "reluctant" to take up, that of Popper's hypothetico-deductivism (*340*, 138). Neubauer's main claim is that Novalis's essential productive pluralism argues against the primacy of the use of hypotheses in the sciences. Neubauer's reluctance is also based upon another reason, since he earlier refers not directly to the notion of hypothesis, but to Novalis's idea of scientific thought as the sensuous representation of concepts and the "mental activity" of "thought experiments", which is a stance very close to that I will take in the present work's view of "experiment" (*340*, 131, 135-136). The epistemological status of the hypothesis has not only been called into question by sociologists of science, but also, as will be discussed, by debates over practical and tacit knowledge. As will be mentioned, Toulmin recognizes the use of hypothesis in modern physics, but the more experience-based sciences he sees as operating with paradigmatic types, which, at the level of the medical practitioner, for example, are a type of knowledge akin to Aristotle's notion of "phronesis". This view of scientific knowledge has affinities with the Romantic use of ideal types, for the types - such as the nerve, the plant's leaf, the magnet and geognostical rock forms - are based upon real phenomena. One aspect of the ethical elements in early Romantic natural philosophy lies, as will be discussed, in their concern for experience-based methodologies: there is a definite real element in their ideal empiricism. One must admit that the moralizing of scientific activities is a matter which is difficult to see fully realized in Novalis's fragments, and in this sense Neubauer is right again to be cautious in interpreting Novalis's views: the rhetoric should not overshadow the reality. The case of phosphorus as the consensual symbol and "mental experiment" of inquirers participating in the pneumatic debate is but one instance of consensus in Novalis's thought. The case of Ritter is, naturally, rather more substantial.

Another issue which comes to light in Neubauer's essay arises out of his comparison of Novalis's and Derrida's notion of language. It would seem worthwhile not only considering language, but to consider briefly what "experiment" could mean to deconstructionists, particularly for the reason, as Neubauer remarks, that postmodernists "pay little or no attention to romantic science" (*340*, 130). Firstly, there is some gap between the relativism of de Man's radical temporality and the ethical and epistemological elements of Novalis's notion of "experiment". Putting this idea into Frank's terms, the temporality of Novalis's notion of "experiment" is transcendent and part of a tendency towards the absolute. Secondly, Derrida's notion of repetitive, never-ending "différance" would appear at first sight to be perhaps compatible with Novalis's idea of re-experiencing experience in concrete thought. Derrida's "différance" would also appear to have affinities with Novalis's wish for endless experimentation and the continual need to question the basis of statements and thought. This is, however, not the case. Novalis certainly sees scientific experiments as repetitions of a function in the way they circulate around phenomena in inquiry, but also as variations - one could say transcendent variations - on the path to formal theory. For Novalis experiment is repetition in the sense of re-experiencing a past experience, but the phenomena or past experience are translated into the language of the imagination in a process of cognitive gain - as Ritter's discovery processes show. Novalis's view of phosphorus does point to the endless repeatability of a phenomenon and its sign - but it is, importantly, employed to a variety of arguably realized theoretical ends, namely a considerable spectrum of views in the pneumatic debate. Realization takes place since all the views form part of the gain in scientific knowledge over gases (and other related subjects in the debate). Frank's critique of deconstructionism can also be put to use in the context of "experiment" and language. Frank argues for the use of the subject in interpreting signs and a minimal identity of signs. As with Novalis, the implication is that signs are variable but necessarily associated with meaning production and cognitive gain. Frank remarks: "difference is never total but rather always partial" (*170a*, 433), and argues for "a theory of the linguistic sign of the sort that simultaneously explains its intersubjective understandability (according to a semiotic key that vouches for the "minimal identity" of the signs) and the non-identity or non-contemporaneity of its message" (*170a*, 439). This approach to language which seeks to avoid Derrida's linguistic regress through the activities of the interpretative subject is also analogous to the way Novalis employs the subject in experimentation to avoid what is now called the "Experimenter's Regress" - a notion which will be discussed in more detail in chapter one and which refers to the circularity in the relationship between practice and theory. Frank's notion of language also bears some resemblances to the tenets of Herder's *Plastik* where language is seen in terms of groups of works, whose meaning is accordingly dependent on their context and the interpretation of the subject.

Let us now turn to Uerlings's notion of a "narrative Konstruktion immanenter Transzendenz". This is an idea that incorporates several meanings. At the level of language it argues that language operates indirectly using representations ("Darstellungen") (*354*, 230). Language is a process which illustrates the signified. At the level of the ideal or "truth", language is transcendentally approaching truth or the absolute in an asymptotic and temporal manner. As Uerlings remarks there is no claim to "Verifizierbarkeit und/oder vollständige Realisierbarkeit" (*354*, 230). In this way Uerlings makes use of Frank's notion of language and his notion of immanent transcendence (see below, section 6 of this chapter).
Uerlings's notion does, however, have its own particular identity. In an extended sense, at the level of scientific inquiry, Uerlings's notion accords with the idea that representations of phenomena ("Darstellungen") - such as Ritter's diagrams - can be used in a process of discovery as mediators between the phenomena (the signified) and knowledge. Uerlings's notion can also be applied to Novalis's notions of history and utopia, as Uerlings himself does in his idea of a "narrative Konstruktion einer erhofften Tendenz" (*354*, 609-613). His notion of a "narrative Konstruktion immanenter Transzendenz" is, then, a highly interdisciplinary term, as he himself points out (*354*, 230-231).

Uerlings's term also helps us to come closer to the answering the tricky question about the Romantic genre of language. If we link Uerlings's important notion "narrational" to Herder's *Plastik*, we can see how groups of words are used in a narrational manner to convey meaning. This means that we convey meaning indirectly through narration with a strong emphasis upon the context of the words: this is an essentially aesthetic method of employing language. The narrational relationship to language is like that of the painter to his materials: it is first in the use and creation of language forms that meaning comes about. Discrete words, like individual strokes and forms of paint do not convey meaning in themselves. On the other hand, one can equally maintain that for Herder a discrete tone such as a cry is already on the path to convey meaning, not in the semiotic sense of the visual letter, but instead in the sound of the word itself (*51*, 5, 11). This aspect of language is directly related to the idea of narration which emphasizes the fact that language is a sound. Poetry is to be narrated, i.e. read aloud, so that meaning is to be conveyed by the sound of language itself: in this sense language is composed of sound signs. This is a major part of Novalis's notion of language: it is his wish that language in its highest form should be plasticized and given musical qualities (*N*, 3, 123-124). This moreover does not mean that language is an autonomous form of conveying meaning with its own code since, in Novalis's view, language's musicality is part of the whole of Nature's "language". Language, in its musicality, comes ever closer to attune itself to the forms of the natural world. Novalis's notion of language is also bound up with what I will refer to later as the "experimental" and symbolic use of language (see below, section 5 of this chapter). Language uses symbolic representations of phenomena (the signified); "experimental" refers both to the essential experiential nature of language and the idea of cognitive gain. Symbolism and "experiment" both point to the indirect use of language in a temporal manner that moves towards gaining knowledge. Uerlings's notion of the narrational goes one step further in underlining the poetic nature of language in the way meaning is conveyed through sound. I have to remain at the level of the symbolic and experimental so as to encapsulate not only the aspects of Romantic verbal language, but also visual language. Ritter's use of his diagrams shows that he does not treat them as discrete semantic units, but as a whole and as a group of representations. The analogy of the sound signs of verbal language to visual language is arguably found in those parts of Ritter's diagrams which hover between the abstract and the mimetic, as a uniquely "concrete" form of visual meaning.

A further aspect, which is worthwhile tentatively broaching now, is the usefulness of Uerlings's term "narrative" for making links between literature and the sciences. Only one aspect will be discussed briefly, that of the use of Uerlings's term for explaining the relationship between Romantic science and alchemy in terms of narrational techniques. Knoespel in a recent article offers an illuminating interpretation of alchemical texts. Knoespel remarks: "Above all we need to acknowledge that alchemy proceeds by employing a metanarrative and a series of local narratives" (*217*, 100). Knoespel points out that alchemists are less concerned with the metanarrative as espoused in the final closure represented by the philospher's stone or "the ultimate transmutation of base metal into gold" (*217*, 99). They are far more concerned in narrating the stages of experimentation and the stages leading to the attainment of the philosopher's stone (*217*, 100). What we have in alchemy then is series of symbolic narratives leading up to the higher metanarrative. In an analogous manner Ritter, and Novalis's use of galvanic symbolism in the "Märchen" in *Heinrich von Ofterdingen*, show the use of a series of symbols or individual narratives to attain scientific theory or a poetic statement. In Novalis and Ritter there is an attempt to unite alchemy's concern with the narration of psycho-physical events with modern science. Lavoisier's chemistry is concerned with the purification of scientific language (*217*, 107), and shifts the use of narrative towards social metaphors "used to describe the cooperation of chemists in their new science" (*217*, 108). Novalis and Ritter, on the other hand, wish to keep narration as a tool of scientific discovery and knowledge formation. Ritter's and Novalis's use of what Uerlings terms "narration", in the sense of representations of phenomena moving transcendentally to the attainment of knowledge, can not only then be seen as appropriate for providing some solutions to the modern problems of over-theorized science, but also can be viewed as linking back to alchemical narrational concerns.

Finally I wish to reflect once again upon these stances of Novalis criticism in terms of "experiment". "Experiment" has proven to be a highly flexible and resourceful term. In the sense of the new and experimental it contains aspects of the pluralism of postmodernism. One can think of Novalis's works in terms of the fragmentary, endless experimentation and radical temporality, but this view has to be corrected by the undeniable epistemological element in Novalis's notion of "experiment". Views about the plurality or epistemological status of Novalis's thought, or as Neubauer puts this, the "centrifugal" or "centripetal" urge in Novalis's thought (*340*, 136), cannot be properly resolved until more work is undertaken on science and the relationship of science to literature in his works. I would argue that perhaps there may be a shift from the more pluralistic stance of *Das allgemeine Brouillon* to the beginnings of some consensus in Ritter's notion of galvanism as also adopted by Novalis. An epistemological element is, as mentioned, permanently present in Novalis's works, both in the sense of "experiment", and in the manner his works are concerned with paths to utopia in the immanent transcendence of the absolute, as Mähl and Uerlings have shown.

The move towards a consensus in Novalis's reception of Ritter could perhaps be interpreted as a move towards the epistemological status of a case study in Toulmin's sense. This would coincide with the threatening theoretical closure of the sciences of the time into disciplines: the case of Ritter would argue for continuing interdisciplinarity and the value of individual discovery over "theory".

Following up from these epistemological concerns one can observe that "experiment" points strongly to practical knowledge in the sense of ethics, but not in the sense of a social construct of knowledge or a normative regulative principle. Instead an instance of a lower level, more practical consensual understanding of communication has been argued for in the example of phosphorus in the pneumatic debate. Ritter's work too has many of these characteristics. "Experiment" above all stresses the possibility of cognitive gain and shows how the subject is employed in knowledge formation. This can be interpreted in terms of narration, representation, experiential knowledge and practical knowledge.

The attempt has been made in this present thesis to approach German Idealism in terms of productivity. This has been done so as to make the theoretical transition to practical knowledge or tacit knowledge clearer. References to "paradigmatic types" and "constitutive rules" will thus be made. This is useful for opening discussions over German Idealism not, as is usually the case, in Idealist terms but in terms of the concrete and empirical.

There is a utopian element in the idea of "experiment" since the concept implies that men can manipulate and ultimately change nature, but this does not point necessarily to the technological mastery over nature. Instead, in Romantic natural philosophy there are ethical elements which strive to respect Nature's own subjectivity. Progression should come about hand in hand with Nature. The notion of "experiment" neither plays into the hands of a pure aestheticizing of nature nor into the hands of hypothetico-deductivists.[4] The plasticizing and experiencing of knowledge bridge science and aesthetics. Novalis's idea of a "symbolische Physik" is charged with epistemological, natural philosophical, and even sociological implications. These issues surrounding Novalis's value for intellectual history will be reflected upon again at the end of section 5 of this introduction, once the relevance of the concept of early Romantic productivity for intellectual history has been sufficiently illustrated.

*2. Premises and methodology.*

This work began, as many of its kind probably do, with a feeling of astonishment and fascination at the way scientific notions can be intimately linked to those of the philosophical, moral and artistic realms in the work of some particular thinkers (in my case this occurred during my first reading of the maxims and aphorisms of Goethe and Novalis). It is only too natural today to assume that science and the humanities have really very little in common. Of course research, particularly in the last decade and more, has worked considerably to change this presupposition. However, even if the notion of the split between the two cultures of literature and science seems to be a theme that has been over-worked, one must not forget that this split, while extensively analyzed by intellectual historians into an open resolution of a plurality of cultures, is still the current life and blood of any education system. The split is, I want to stress, still very real. Moreover, even for intellectual historians the analysis and dissolution of the two cultures as a bogus concept has lead in general to a response oriented around the humanities (e.g. around sociological perspectives, genres and rhetoric) and not always to a resolution taking a more equal account of both scientific and artistic knowledge in their points of transition. It is particularly with a conceptually "tighter" resolution of the sciences and the humanities in early German Romanticism that this work is concerned. It is in the role of practical knowledge, a notion of knowledge that lies prior to the activities of arts and sciences themselves, that this work attempts to fend off the relativism sometimes apparent in humanities-oriented responses to intellectual history. In this sense, this work attempts to take a more equal account of artistic and scientific knowledge since factors are studied which are prior to the inception of both art and science.

Before treating these issues in greater detail, I wish first to give an indication of the stance of this dissertation. The issues concerning the status of literature and science studies are well enough known to allow me to forego a long and detailed introduction to the subject.[5] I wish instead only to delineate some key issues so as to position this dissertation within the debate. It goes without saying that until the 1980's it was common, in the main, to explore the arts in terms of science. More recently, the reverse approach has been undertaken under the banner of genre studies. The value of genre studies, as I understand Dear's project, will be discussed in more detail below, but the main thrust of this approach, that science is determined by literary style, is questionable. Common sense argues first of all against such a viewpoint: it is difficult to imagine how science can be affected by rhetoric alone. There are also some epistemological and linguistic problems raised by such a stance in genre studies. It would seem, in nuce, that literature and science studies point to the difficulties of upholding positions that tend towards linguistic purism or scientific absolutism; none the less, projects such as genre studies are, of course, seeking to bring science and literature closer together.[6] At the moment, opinion over literature and science studies coheres around the project of treating them both in terms of cultural discourse. This stance provides the means to observe how both discourses move in and out of one another. Influence is then more justly seen to be a bi- or uni-directional affair. These types of studies are correspondingly broad, blending elements of many discourses, be they historical, philosophical, scientific, social, psychoanalytical or literary. Thus, Rousseau and Gillian Beer, for instance, have a more reflective stance to the way sciences and literature effect one another than that of one-directional methods. Rousseau has shown how notions of sensibility may have been imported into science from literature, yet his final stance is cautious over the exact relationship between science and literature (*266*). Gillian Beer has undertaken work on Darwin and Hopkins in the same manner as a study of cultural discourses (*138*; *140*). This type of reflectivity points to questions surrounding non-causal relationships between science and literature. Naturally, giving up causal relationships entirely can lead to another extreme: that of open-ended pluralistic discourses. This is, of course, a necessary part of the development of this area of study in intellectual history: exploration of the way literature and science interact in all possible forms is the way forward. None the less, there is a large question haunting these explorations: what is the new theory or new project going to look like that seeks to unite or draw closer the arts and the sciences? This question must be permanently reasserted to give the whole project perspective and, arguably, sense. Relativism is not always, but can sometimes be just as much a danger as scientific absolutism or aesthetic purism. Sociological relativism, as now increasingly found in studies in the history of science, is another danger which threatens the sense of the whole project concerning cultural discourse; although, as discussed below, there are sociological perspectives in the history of science that cannot, given the sheer depth and breadth of their analyses, be reduced in a facile manner to relativism.

Returning to the question of the sort of theory needed to unite the project revolving around the relationship of literature and science, Rousseau's and Beer's reflective multiple discourse approach points to the gradual accumulation of transitions between discourses. Weininger, in his introduction to the collection of essays, *Literature and science as modes of expression*, taking up Elinor Shaffer's stance, sees the answers to the question of a theory for science and literature lying in "a new understanding of the nature of literature and of language" (*131*, xxii; *278*). Significantly for this dissertation, Weininger sees potential here in Novalis's thought. Commenting on Neubauer's work, Weininger points to Novalis's "insight into the centrality of the imagination for all human constructions, including science" (*131*, xix) and, further, commenting on von Molnár's work, remarks on the way "Novalis conceives of language as a bridge between theoretical reason (science) and practical reason (ethics)" (*131*, xx). A possible answer to Weininger's call for an exploration of the deeper relationship between literature and science in terms of language will be undertaken in the light of Novalis's reception of Ritter. The case of Ritter's work on galvanism is a realization of Novalis's concern for natural philosophical productivity in the unification of practice. It will be shown, in this instance, just how close "res" and "verba" come to another. Importantly, this meeting of "res" and "verba" does not state that art directly effects science: it proposes that it is through a common methodology that they can at all meet one another, and this points more exactly to the positioning of this dissertation in literature and science studies. Elinor Schaffer has pointed to such further areas where a possible theoretical base for literature and science could lie. She refers above all to the increased interest in practice, both in literary theory and history of science. Among the variety of issues she raises, including the notion of "dangerous knowledge", the most relevant ones for this dissertation are the possibility of a language of the inner consciousness and the notion of practical knowledge. When discussing the idea of consensuality and the use of models and metaphors in knowledge formation she points, after Ziman, to the fact that consensibility may be a more appropriate term for the consensus account of knowledge formation, given the difficulties involved in stipulating a language of inner consciousness (*282*, xvi; *302*, 189). However, she also makes reference to several areas of thought where the language of the inner consciousness may become a possibility. Two of her suggestions will serve well to point the reader in the direction which this dissertation is travelling. The notion of active knowledge involved in the performance of knowledge is one. This approach to knowledge formation is linked up at hermeneutic levels with this dissertation's concern for experiential knowledge as "experiment". Another path she points to is that suggested in Toulmin's work on practical knowledge and the case study. I will only briefly rehearse here the way in which these two approaches are relevant to this dissertation, since these themes will elaborated upon throughout the course of this work. I should like to argue that both of these approaches are, perhaps, of use for offering up considerations about a type of theory for literature and science studies. What this dissertation emphasizes is the cognitive gain in the notion of "experiment". The use of experience brings the thinker closer to phenomena and also to the experientiality of knowledge itself, and, in this sense, argues for cognitive gain. The issues of experiential knowledge link up directly to Toulmin's discussion of practical knowledge, and further, to the use of case studies in knowledge formation. To express this aspect briefly, the idea of a case study, as employed in this dissertation, implies the reconstruction of theory in an interdisciplinary manner. Novalis's reception of Ritter's work illustrates just this, and, in addition, argues for the particular role of the individual inquirer in such processes of knowledge formation. Ultimately, the notion of unifying practice proposed here argues for a language of the inner consciousness based upon the interdisciplinary reconstruction of theory and the use of experiential knowledge. These aspects of knowledge formation both work at bringing the languages expressed in the purposiveness of Nature and of the individual inquirer's imagination close together. Due to the particular role of the individual in this notion of knowledge formation and consensuality, this understanding of Novalis's thought (and, consequently, as is argued, of early Romantic thought in general) cannot be seen alone in terms of the epiphanic. The unification of Nature's purposiveness and man's consciousness is the major goal of the early Romantics, but, this is, arguably, a project with some notable consequences for the notion of individual knowledge. Furthermore, the type of aesthetics proposed here accords with the idea of dangerous knowledge, since it is an aesthetics that has the rigour and the goads of a scientific method (aesthetics is, of course, a key part of the scientific method of the early Romantics). Interestingly enough, some of the works in the history of science Elinor Shaffer refers to are not recent. This highlights the way historians of science have, perhaps, in recent years, set aside the issues concerning hermeneutics, metaphor and this type of language use in the sciences.[7] This dissertation shows the use of models and metaphors (as part of Novalis's rhetoric of experiment) in reconstructing theory and in methodology. This is the meaning behind the notion of unifying practice: the path to consensuality afforded by the use of such metaphors and models. This is the path that this dissertation is travelling down, to work at offering up some form of epistemology for linking the arts and the sciences. It is in this sense that this dissertation suggests tighter conceptual links between the arts and the sciences than are perhaps found in more pluralist approaches. In the conclusion the views of a historian of science, Jardine, will be discussed in order to bring further perspective to the early Romantic method. It will be tentatively considered to what extent they fare up to Jardine's views of aesthetics in the sciences, and, also, how practicable their views are. In this manner an attempt will be undertaken to add some more perspectives to the roles of practical knowledge and aesthetics in the sciences. The purpose of this work does not lie in making an explicit proposition for a theory for the field of literature and science; it is far more my concern to compare, to contrast, and to attempt to enhance different approaches in intellectual history. In effect, my main concerns are to attempt some "translations" of the various approaches into another, and to illustrate some aspects of early Romantic methodology which could be of use for current debates over intellectual history.

I began my studies of Novalis under the premise that it would be best, given the breadth of Novalis's scientific interests, to concentrate on one scientific discipline and to present its links to Novalis's literary achievements. However, this approach, rather more swiftly than expected, fell to the wayside. This state of events occurred during my reading of *Das allgemeine Brouillon*. It was there that an irreversible hunch overtook my previous interests. A problem arose for me in seeking to interpret an important fragment which had hitherto not been adequately analyzed. It dealt with notions of Neoplatonism, experiment, and method (*N*, 3, 445; see below, chapter 2, section 1.7). What did this seemingly cryptic but clearly intellectually cogent fragment actually mean? My hunch crystallized around Novalis's extensive and cryptic use of the term "experiment". It was this pervasive term which lead me away from the study of a specific discipline to the study of many disciplines and their origins, methodologies and unities. It became clear that work had to be carried out on that area of knowledge which is prior or common to the disciplines. As remarked, this happened far quicker than expected, for it is not often that a thinker's stance to knowledge as a whole can be encapsulated under a one major notion. Not that this is the case entirely with the term "experiment"; there are many other key terms in Novalis's thought; none the less the term "experiment" is a key term, and certainly a term under which much of Novalis's thought can be analyzed with effective results. The difficulty of ascertaining key notions is particularly the case with thinkers such as Goethe and Novalis, who are wary of pinning themselves down to specific doctrines. The term "experiment", as will be argued, possesses particular merits in this respect, since it has significant undoctrinal implications. This dissertation attempts to show just how important the issues arising out of Novalis's understanding of the term "experiment" were for many of his activities, and indeed, how significant this understanding of "experiment" is for early Romantic science in general. Furthermore, it will, I hope, provide an epistemological and contextual base for further studies on Novalis; equally, I hope it contributes to our awareness of early German Romantic science.

There are two works to date which provide a general survey of the sciences in the Romantic period: Gode-von Aesch's work of 1941, *Natural Sciences and Romanticism* (*175*), and the recent series of essays in *Romanticism and the sciences*, edited by Cunningham and Jardine (*159*). *Romanticism and the sciences* offers a wealth of material showing the philosophical viewpoints and intellectual traditions in an array of Romantic thinkers. The work provides sections on the notion of Romanticism in its philosophical and institutional context, on the organic and inorganic sciences and on science and literature. Gode-von Aesch's work, on the other hand, chiefly studies the notion of organicism in Romantic thought. This present dissertation wishes to complement these studies by viewing some key examples of early German Romantic thought under the notions of practice and methodology. It's outlook cannot pretend to be broad as the collection of essays in *Romanticism and the sciences*, on the other hand it attempts to provide a modest synthesis of early Romantic thought in the issues of practice. The synthesis Gode-von Aesch strives to attain, as mentioned, is that of the idea of organicism in the Romantic thought. With respect to Gode-von Aesch's work, this present dissertation wishes to provide a methodological basis for analyzing Romantic notions such as organicism. Gode-von Aesch emphasizes the Romantics' unfulfilled quest of attempting to explain the whole of nature and their doctrine of organicism (*175*, 12-13, 123, 267). This present work moves outwards from the key natural philosophical tenets of Novalis and Ritter, and specifically not only from their natural philosophical doctrines, but from their natural philosophical method. It is this attempt to capture the tenets and moods of the early Romantics, as, for example, in Ritter's early work on galvanism, or the early experiments of Schelling with forms of natural philosophical systems, that arguably puts the aims of the early Romantics into a more appropriate perspective. This work treats the genesis of Romanticism and attempts thereby to capture their views by a study of the initial "workshops" where they formulated their key ideas. Unlike the above mentioned studies, this dissertation does not attempt to tackle the later Romantics, although a comparison is made in this introduction between the works of the early Romantics and Oken. Perhaps this tentative comparison between the two can throw some light upon the manner in which Romantic thought developed - but this is, I wish to stress, only tentative. More importantly, this present dissertation wishes to illustrate how a central concern of the early Romantics lies in the justification of their views and how this is related to experimental practice and their notion of a theory of practice.

It is of interest to note that Novalis is often cited by Gode-von Aesch and used substantially by the editors in their introduction to *Romanticism and the sciences*. The present work suggests that their recourse to Novalis as a keystone for the chief characteristics of Romantic thought is tenable, but not entirely for the reasons they put forward. The importance of Novalis for capturing the Romantic biocentric or physiognomic view of the Nature (Gode-von Aesch) or for showing the Romantic quest for the development of a multiplicity of disciplines (Cunningham and Jardine) represent certain, specific, but selected aspects of the ways in which Novalis is characteristic of Romantic thought. Cunningham and Jardine do further point to Novalis's view that the experimental disciplines are to be seen in terms of artistic production, but this notion is then discarded as being "so solipsistic as to rule out communal enterprise" (*159*, 6-7). By contrast, it is an aim of the present work to show how Novalis's ideas on a method of knowledge formation, as formulated in his notion of practical knowledge, which is indeed related to artistic production, was a method capable of communal enterprise, as this was undertaken by key Romantics such as Ritter and Humboldt (1769-1859), and, not least, by Goethe.[8]

Roy Porter comments that, although *Romanticism and the sciences* succeeds in unraveling intellectual traditions, "a much more fully researched history of the rise of the intellectual classes" is still needed to explain Romantic science or the relationship between literature and science (*281*, 276). It would appear, however, that there is still work needed on analyzing the philosophical and scientific issues of the age - many of which still lie open. *Romanticism and the sciences* provides a mass of intellectual background which is in any case necessary for Porter's task. But is Porter's view the only solution at this stage in Romantic studies? I think not. What do all the fragments of Romantic thought point to? I say fragments, even though many Romantics presented completed works, because their works remain fragments given their intention to capture the whole of nature and experience. Their works are certainly not unscientific half-fulfilled dreams, for there is a strong empirical and philosophical base to their works. It is common to view the fragments of Romanticism as the quest for unity, but if Romanticism is left at that - as a unifying urge - this is of no explanatory help. My thesis argues for a different approach. It studies, as mentioned, the genesis of knowledge in Romanticism. Questions are posed about the causes leading to a belief in unity, and great attention is paid to the steps undertaken to justify the idea of unity. Unity is approached through a case study of Romantic science, in the work of Novalis, and in its relation to Ritter, and also through the assessment of Novalis's philosophy of practice. In this introduction an attempt is made to put the issues that arise out this case study and of Novalis's philosophy into a proper perspective as concerns intellectual history, Romantic thought, and a theory of practice or practical knowledge.

Given its theme of the link of practice to Romantic thought, this work has a particular place within the discipline of intellectual history. It is written in a spirit that applauds the awareness of the need for reflection upon the traditional notions of the disciplines, and stresses the need for interdisciplinarity. Indeed, the chief subject is the notion of a correct method and the search for reliability in knowledge. Where, one can say, is a better place to tackle such an enterprise concerning the questions of reflection and method than in the era of the Romantics where the disciplines as we know them today have their origins? This present dissertation's stance to intellectual history has already been briefly sketched: in the remainder of the introduction it s positioning will be more precisely elucidated. Before treating the areas of genre and practical knowledge, I wish first to consider the position of this thesis in relation to current historiographic methods in the history of the sciences.

History of science has currently two major movements, those taking the internalist/intellectualist approaches and those taking the externalist/praxis-oriented approaches. The sociologically oriented externalists pose a significant threat to anybody combatting relativism. Social determinism is always implicit in such approaches. Nevertheless, Shapin's and Schaffer's work (*286*), for example, has done a great deal to open up the debate on how consensus is attained in the sciences and their works cannot be reduced to a notion of relativism. I will return to their work later when speaking of the importance of achieving a variety of historical approaches when examining the history of science. For its main part, this work makes no claims to any in-depth examination of the subjects that the externalist interest theory approach tackles, such as the role of social, political or professional interests in the attainment of consensus. Likewise, it does not trace the breadth of material needed to satisfy a network theorist such as Latour (*228*; *229*). It does, however, offer much material on literary and aesthetic strategies leading to consensus, which is indeed of interest to network theorists (*210*, 194-195). Furthermore, of interest to externalists is the chapter dedicated to Novalis's views on the pneumatic debate. There the contextualization of phosphorus broaches the notions of the theatrical and the anecdotal in the sciences. The widespread use and knowledge of phosphorus, both in the sciences and for purposes of entertainment, place the substance in a social setting.

However, it is essentially an intellectualist approach that is here undertaken (the chapter on the pneumatic debate is in essence also intellectually oriented). This is, according to Jardine, what constitutes "the most fundamental level of content, the content that underlies both the research agendas of the sciences and the factual and theoretical doctrines of the sciences" (*210*, 152). Jardine also supports the interests of externalist historians and praxis-oriented sociologists. He sees the primary determinants of his notion of "the scenes of inquiry" manifested in the local practices, institutions and technologies of the sciences. Jardine's ultimate aim is the synthesis of both schools of thought, the internalists and the externalists, albeit as he states with a significant emphasis on local practices, methods and doctrines. Since this work has little externalist orientation it offers no synthesis in Jardine's sense. At another level it does provide the beginnings of some synthesis of internalist and externalist approaches in the period under examination. The reason for this lies in its concern for practice, but only in an extended way could this be interpreted as an externalist approach, since practice in the works under study here is defined in an intellectualist way. In fact the notion of practice here is heavily imbued with the Romantic natural philosophical outlooks and with their aesthetics. What this work hopes to provide, as a useful extension to sociological contextualizations, is material on the more tacit practices of the Romantics and their links to the Romantic natural philosophical theory. This can perhaps be seen as having further externalist implications for the reason that it is argued that the notion of practice applies to several major Romantic thinkers, and not to one individual alone. The findings on Novalis and Ritter, which form the centre of my focus, are also applied to Werner, Goethe, Humboldt and Schelling. In the context of the present growth of externalist approaches, and the present state of research into Romantic science, I argue that a fundamentally intellectualist approach is still required to capture the aims of early Romantic science.

The way in which practice is approached here is, as already implied, intellectualist in a particular fashion. Externalists have criticized traditional intellectualist approaches of the post-Koyréan school for their metaphysical determinism and for the way in which such approaches put forward an overly passive role for the "cultural actor". Thus the externalists' point is that in the writings of intellectualists "culture uses the actor" whereas in their works "the actor uses the culture" (*284*, 111). By contrast, I here put forward an "active" intellectualist approach since the thinkers under study are not seen to be passively conducting their inquiries under the influence of the metaphysical, but instead, as with Ritter for example, natural philosophy is seen to be actively made. The Romantics present us with a field of "active" metaphysical works. The metaphysics is undeniably there as an influence, but at the same time the metaphysics is categorically not treated in a passive way. This approach is made possible since my work concentrates on the details of discovery processes: the active metaphysics can be seen at work in practice and in the process of knowledge formation. A similar stance is argued for in relation to Goethe and Humboldt. The view ought to come as no great surprise, given the Romantics' concern for the processes of history, but the applications of this "active" intellectualism to Romantic natural philosophy have been neglected. Von Engelhardt makes a related point regarding "historical consciousness": the Romantic concern for history cannot be seen as passive, for in their concern for processes they are continually absorbing tradition and adapting it in a creative fashion. In fact, the Romantic notion of the process of history is exceedingly broad, so that thinkers such as Novalis and Ritter are dealing at one and the same time with the history of thought, culture and nature. Von Engelhardt comments:

> The historical consciousness of the natural sciences in the Romantic period not only merits the historian's attention, it is also of lasting significance. Today again the concept of development has become a key-word for practice and theory. Nature, culture, the individual, society and science all develop, and there arises the question of concurrence and divergence of the types of development in these diverse realms of reality ... In general, the development of science is nowadays not related to natural evolution, but nevertheless some connections have become increasingly clear. Nature has to be understood as part of culture, and in the same way culture has a natural foundation. The development of culture threatens evolution, and achieving insight into the shared fate of nature and culture is an essential task for the future (*168*, 65).

The last part of the quotation relates to the purpose and ethics of science and to ecological issues. I will only briefly refer to these below when discussing the major tenets of Romantic natural philosophy (see below, section 5).

Historical consciousness and tradition are key terms for understanding what can be called an "active" intellectualist approach. Historical consciousness relates at obvious levels to the history of nature, of the human race, of culture, of ideas. At a less obvious level it relates to the major concern of this work: the history of the practice of ideas and the ensuing notion of an epistemology of practice. This work's approach arose out of the Romantic concerns - given their concern for history it is not surprising that material is available on the history of discovery, of the practice of ideas and of an epistemology of practice. That this is not only a Romantic concern, but also a concern of history of science today can be illustrated by the following examples, where related themes have been broached. Thus, for example, Nickles's notions of generative justification and induction relate closely to this work's concern for practice and know-how (more on the issues of practice will be said below) (*248*). Hesse speaks of the role of models in science in building up a "sufficiently complex observation language" for the attainment of formal theory (*196*, 46). Two more works also serve to pin point the aims of this work. Rudwick shows the emergence of a visual language for geology in his portrayal of how diagrams were used to represent geological ideas in the eighteenth and nineteenth centuries (*268*). Gooding's work on Faraday's (1791-1867) use of diagrams as non-verbal concepts during the process of formulating his theory can be viewed as a straight equivalent to one of this work's concerns: the role of visual elements in discovery processes (*176*). However, this work analyzses the aesthetics of diagrams in greater depth, and, given the Romantic context, provides an epistemology of practice in Novalis's terms and in those of other early Romantic thinkers. It is also concerned with the variety of ways theory or meaning is conveyed - be it visually, in open-ended concepts or even in phenomena themselves. The study of Ritter shows how his galvanic theory came into being and how Novalis provides an appropriate epistemology for discovery processes based upon his fundamental notion of a theory of practice and upon his reception of Ritter's work. The genesis of ideas, how ideas are conveyed and the way the early Romantics see idea, representation and phenomenon all folding together and enhancing one another are the major concerns of this work.

The notion of open-ended concepts gives this work a particular niche in intellectual history since it deals not alone with how the early Romantics had a theory of practice, but also how they were operating, in their eyes, within a tradition of ideas. They draw on a tradition of open-ended concepts and adapt them consciously to their purposes. In this sense the history of the practice of ideas has a particular significance: it covers the early Romantic epistemology of practice, their own notion of a practice of ideas, and how they view a broader tradition of the practice of ideas. Thus, this thesis does not treat the way metaphysics affects empiricism alone, nor does it treat practice alone, nor does it treat social practice as such, nor does it treat the literary practice of science alone (this work's relationship to genre and rhetoric studies is considered fully below); instead, as a whole, it treats the practice of ideas.

The particular awareness that the Romantics had for history and tradition is highly related to a problem of our times: that of the methods of attaining consensus in knowledge. The notion of a tradition of open-ended concepts is, admittedly, too all-encompassing for a proper description of consensus. But I hope that my thesis mitigates this problem by revealing the type of methods used to attain consensus in early Romantic science by studying the particular case of Ritter's work on galvanism. The key points of this analysis are then extrapolated to other Romantic thinkers, with whom comparisons are drawn.

Reference is made to other Romantics for the most part in this introduction. The key parts of their notion of natural philosophical inquiry and method are compared so as to gain, I hope, the beginnings of an overall view of consensus in some of the main figures in early Romantic science.

The concern of Romantic thinkers for history and tradition, and the way in which this work specifically approaches this phenomenon in what is referred to above as the tradition of and the practice of ideas, reveal the fallacies about, and prejudices commonly held, against, the Romantics. This work emphatically argues for the Romantic concern for experimental practice and a philosophy of natural philosophical practice. It is at pains to show that what is often held to be Romantic speculation is in fact greatly concerned with the issues of practice. In particular, under the issues related to tradition and practice, it is argued that the phenomenon of Romantic natural philosophy did not come about by a change of "episteme" in a Foucaultian sense. It is, I think, not the case that through the emergence of a Romantic natural philosophical "episteme" that new approaches to inquiry were made possible for the Romantics. This would lead to the interpretation that the Romantics came to their findings and methods of inquiry through speculation. The Romantics' concern for tradition and practice show that this view is untenable. There is no denying that Romantic thought is composed of speculative elements, but the type of speculation they undertook cannot be interpreted in the modern pejorative meaning of the term. Romantic speculation involved a conscious confrontation with and adaption of past theory and methodology. The work *Romanticism and the sciences*, for example, has a wealth of examples to support this view. When, for instance, Schelling speaks of "spekulative Physik" he is highly aware of the historical career of the sciences. As will be discussed below, it is, in his view, the task of natural philosophy to avoid the traps for the scientist that the history of science reveals. A further prejudice often held is to belittle the Romantics' alleged lack of empirical or experimental orientation. This prejudice is here put aside by the study of the way the early Romantics, and specifically Novalis, problematize the notion of "experiment" itself, both in practice and in the epistemological approach to experimentation. A final prejudice dealt with in this work is that the Romantics' quest for unity led, in the end, to no real gain in "scientific" knowledge. Through this work's concern for "tighter" conceptual links between the sciences and the humanities in the Romantics' notion of a theory of practice, this relativist threat is, to some extent, fended off. On the contrary, it will be seen that the Romantic unifying urge did take a very specific form; this will be seen by relating it to their notion of method, by defining key precedents, and by showing examples, as in Ritter's work, where the unifying urge did lead to a real gain in knowledge.

*2. Aspects of genre in early Romantic natural philosophy.*

Before discussing the issues surrounding practice and "experiment", this thesis's relationship to genre and rhetoric studies will be charted. Discussion of the stance to genre and rhetoric studies has been postponed until now because of the need to dedicate space to Novalis's and other Romantics' notion of language. Furthermore, this thesis's relationship to genre studies can only properly be seen in the context of practice and "experiment", which will need to be considered after some introductory comments on genre.

Studies in the fields of genre and rhetoric have been concerned with the roles played by literary and linguistic factors in the development of the sciences. Latour's and Woolgar's *Laboratory Life* (*230*) opened up studies into the ways scientists select and manipulate information in the presentation of their findings. Gilbert and Mulkay's *Opening Pandora's Box* (*174*) traces similar themes concerning the various uses of rhetoric scientists employ in denouncing or approving of scientific work. Shapin's work on Boyle traces the rhetorical strategies and beliefs underlying Boyle's science (*285*). Hannaway has shown how Libavius's *Alchemia* is set out according to the precepts of the dialectician and pedagogue Ramus and, further, how Libavius's work gave rise to a tradition of didactically oriented chemical works up into the eighteenth century (*184*). Anderson (*133*) reveals the rhetorical techniques Lavoisier used in changing the direction of chemistry away from the previous philosophical chemistry to his idea of modern quantitative chemistry. Importantly, Anderson relates this shift not only in terms of chemical theory itself but also in terms of methods of explaining experimental findings and in terms of changes in experimental practice. Dear studies the narrative accounts of experiments in the works of Galilean and Jesuit scholastic writers within the context of Aristotelian discourse of their time (161). All of these works are concerned with the manipulation of language to scientific ends, and the present work fits into this realm of intellectual history, albeit, as will be argued, with important distinctions.

This dissertation's main claim to enter this area of study lies not, as might be expected, in the treatment of the aphorism, although this approach is to a certain extent implicit, since the majority of the references made to Novalis are to his aphorisms. But the genre of the aphorism in Novalis's and Ritter's work deserves, I believe, separate attention: it would lead to a valuable and much needed analysis of the structure and purpose of Novalis's encyclopaedic programme in *Das allgemeine Brouillon* within its full natural philosophical context. However, at this stage of Novalis scholarship, it appeared far more pressing to concentrate on the genre of "experiment" in early Romantic natural philosophy. The study of the meaning of "experiment" for the Romantics is cardinal for an understanding of their approach to inquiry. It is, I would contend, not the much discussed aphorism, but the genre of "experiment" that explains much about the formation and structure of the genre of early Romantic natural philosophical works themselves. As already indicated, I approach the literary structures and factors within the early Romantic natural philosophical works primarily through the early Romantic notion of practice - which is a general form of knowing antecedent to, but reflected in, any literary or linguistic techniques they employ. As opposed to treating language as a discrete item, my work is primarily concerned with a way of experiential thinking, the application of the Romantic world view to this way of thinking, and the ensuing formation of knowledge. The argument goes beyond the study of the discursive or formal word to analyze the notion of concrete and experiential thought in concepts, symbols and visuals. Not only is it necessary to analyze this part of Novalis's world view first of all - to put him on the map as a thinker in ways which Novalis scholarship has not done so up to now - it also becomes a necessity to explain the Romantic use of language itself.

The aim of genre studies, as Dear states, is to show that language is more than "a transparent medium of communication" and that "language is in fact a shaper (perhaps a realizer) of thought and an embodiment of social relationships" (*160*, 4-5). Thus the goal, in Dear's view, is to provide a synthesis of the poles of social and intellectual thought in the study of the cultural history of science. This would then bridge the social and intellectualist divide by studying "the various means by which individuals interact so as to create meaning and knowledge"(*160*, 9). My findings do not disagree with the value of genre studies in this sense. My argument never accepts the naive transparency of language, nor does it doubt the fact that language can, to varying extents, shape thought, nor does it wish to call into question the view that language reflects and assists social and intellectual interests. The main part of this work is, however, concerned with a quite different matter, which, it is argued, is more pertinent to an understanding of the Romantics at the present: namely that which is fundamental to the individual's own use of ideas and language. The work discusses Novalis's views on ideas and language, Ritter's process of discovery, Goethe's notion of scientific method etc., and then goes on to draw conclusions about a notion of knowledge formation generally applicable to key Romantic thinkers. The social aspects of language are treated only in the sense that a common Romantic outlook is suggested, but this comes after the treatment of individual attitudes to language. Methodologically, it was necessary to approach the social basis of language (in the sense of a communal enterprise) by first explaining and then extrapolating from the individual's use of language. It is not primarily social relationships that are found in the Romantic use of language, for their idea of practice is anterior to social considerations. Since early Romantics are concerned with the creation of knowledge, and with finding new systems of knowledge, it is understandable that notions of practice loom large. A notion of practice was required to keep the breadth of their experimentation with knowledge under control. The personal knowledge of the individual needed to be justified by reference to practice before anything approaching consensus could be attained. Thus it is that the Romantic use of language is not profitably explained only in terms of social usage, or, in terms of the formal and the discursive. In this work the tables are turned: language is not the shaper of thoughts, experience and practical thought shape language. Language is not only an embodiment of social relationships, but more so of the way the individual asserts himself. Language's epistemological value is relativized; language is a tool, just as other forms of knowing are tools too. All other forms of knowing have their own languages. It is shown that for Novalis there were many forms of language - indeed, for him, all purposive processes can be understood as languages. Written language itself is but one of many "languages". What is key to Novalis is that all of these "languages" need to be treated in a phenomenal way: that is, the language of the painter in works of art, the language of the scientist in e.g. the depictions of his experiments, the language of mathematics, or the language of the author in his literary texts, all of these languages are treated as mediums of which the user has to gain practical awareness. Important to Novalis is not written language per se but the plurality of languages involved in knowledge formation. In dealing with knowledge formation, Novalis thus turns his attention away from the languages themselves to a type of knowing that is common to them all: the process of attaining skills in a particular language, and this, in Novalis's view, is the capacity needed to have a feel for the original forms of the various languages. Each area of knowledge creates its meanings using its own particular mediums. What is common, in Novalis's view, to all the languages, is the way they create their meanings, i.e. the method of treating knowledge phenomenally and experientially. Thus language itself (i.e. the written word), in Novalis's understanding, is not the true fundament of knowledge formation, even if, as cannot be denied, language does "shape" knowledge.

For the early Romantic thinkers under study in this work it is argued that it is the various mediums of natural philosophy and the experiential approach to knowledge formation, not written language itself, that bring about meaning and knowledge. Their concern for the genre of "experiment" and experiential knowledge forms the basis of my attempt to uncover a "tighter" conceptual link between the arts and the sciences. This is an approach which does not seek, in the main, to show that the arts affect the sciences (e.g through rhetoric), nor does it strive to reveal how the scientific affects the arts (e.g. how key notions of natural history are reflected in literary works); both of these effects are the inevitable outcome of my study; but I hope to show a level that the arts and the sciences have in common; however, this is, importantly, a unification of interests prior to literary and scientific interests. By contrast, genre studies are generally concerned with the effects of language in its own right. Dear shows how Aristotelian rhetoric effects the natural philosophical debates around Galileo's work (*161*). Shapin and Schaffer describe how the natural philosophy of Robert Boyle and the early Royal Society was concerned with expressing the "matter of fact" and that they employed a highly descriptive genre of experimental reporting (*286*). In his analysis of the changes in Reils's *Archiv für die Physiologie* into the later journal, the *Deutsches Archiv für die Physiologie*, Broman argues that genre and scientific theory operate together and change together (*147*). All of these genre studies move away from the traditional intellectualist study of doctrines to the study of practice at the levels of the technical, literary and sociological. Through these studies of genre, the natural philosophies of different epochs attain a new definition. Galileo's natural philosophy is based upon universal statements and axiomatic deductive argumentative structures; Boyle's natural philosophy is one of "appearances". Broman argues for the shift away from the early journal's interests in the pedagogic, argumentation and individual conversations to the later journal's concern for the descriptive and multiparty conversation (*147*, 32-33, 39). Broman's work offers up an intepretation of Romantic natural philosophy in the shift from Reil's original concerns for seeking causes in individual phenomena to the later journal's Romantic natural philosophical approach where the causes were already found in the dynamic relationships of phenomena. Thus, in Bromans's terms, it is implied that Romantic natural philosophy is one of description based on dynamic principles. Although this may appear to do a service to Romantic natural philosophy, the key part of Broman's argument acts as a double edged sword. Indeed he remarks that the later journal, in its shift to the descriptive, stood under the "thrall" of Romantic natural philosophy (*147*, 35). This approach captures the Romantic concern for practice at the level of empirical description, but overlooks their concern for an epistemology of practice. Yet Novalis, Schelling and, of course, Goethe, are all concerned with reflection upon, and experimentation with, higher principles; furthermore the Romantics were greatly concerned with the issues of the pedagogic (*279*, 42), which was present in the earlier journal but was eliminated in the later "enthralled" journal. This is a case of genre studies where analysis of issues such as literary form has ignored primary intellectualist issues. The example supports my view that more analysis is still required of the intellectual history of the Romantics before focussing solely on issues of genre.

Schaffer's notion of Romantic natural philosophy comes considerably closer to my concerns. Firstly, and wisely, he discards the term "Naturphilosophie", precisely for reasons such as the prejudice which is still latent in Broman's work. Schaffer retains the term "natural philosophy" to keep in mind the links with previous traditions of experimental philosophies and "the complex and important connections between the changes in the culture of the sciences which took place in the German lands from the 1790s" (*271*, 83). One should add, as is well known, that the peaks of natural philosophy are traditionally seen in the pre-Socratics, the Renaissance and German Idealism (*145*, 7). The Romantics, with their high level of "historical consciousness", make explicit reference to these past traditions of natural philosophy as well as to the rise of the modern experimental natural philosophy. This work attempts to account for both of these strands of natural philosophy and their effects on Romantic thought. It is particularly in Novalis's notion of "experiment" that such a blend of traditions is traced. It is highly significant in this context that Novalis's recourse to Plotinos is not primarily concerned with natural philosophical doctrines, but with natural philosophical method. As will be discussed, it is in Plotinos that Novalis finds a tradition for his theory of practice.

Schaffer defines the natural philosophy of the Romantics as one which analyzed "active powers". In his view, Romantic natural philosophy "appealed to the active powers of the genius to legitimate its natural knowledge" (*271*, 83). When Schaffer points to the Romantic aesthetics as "the key to the status of genius in natural philosophy" his interests come exceedingly close to those of this work. It is in their aesthetics and notions of practice that the links between the powers of the observed and their own powers of perception can be found. My argument can be seen as presenting another part of the Romantics' story in addition to Schaffer's more sociologically oriented interpretation in terms of power and performance. If Schaffer's work offers us a study of the genre of genius in the Romantic period, not in the form of a traditional intellectualist study of doctrines, but as a study of practice predominantly in terms of the sociological, this work offers an interpretation of Romantic science in the form of a study of practice at epistemological and aesthetic levels. Where Schaffer closes his broad, in-depth analysis of the time with terms such as "genius" or "sublime physics" this work takes over to study Romantic method itself in-depth. Romantic natural philosophy is thereby defined as "experimental", and under this term is understood its concern for the practical knowledge of Nature, both in the phenomenon of thought and in other natural phenomena. That, in turn, explains this work's interest in a "tighter" conceptual link between the arts and the sciences in a philosophy of practice. The early Romantic interest in practical knowledge is a unique blend of Neoplatonic epistemology and ontology, the experience-oriented rise of science and German Idealism. The Neoplatonic tradition, particularly as seen in Novalis's idea of a "phenomenal" calculus, is an important source for early Romantic notions of practical knowledge; the early Romantics criticize the empirical sciences for their unreflective treatment of inquiry, but praise them for their return to experience. The Idealism of Kant and Fichte is praised by the Romantics for having provided a philosophical base for the subject, but Kant is criticized for his notion of science and objective knowledge - precisely for his unwillingness to approach practical knowledge in natural philosophy.

Within intellectual history there are, clearly, a variety of available approaches for the historian. One of the most comprehensive approaches to consensus attainment in the sciences is that presented in the interest theory work of Shapin and Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle and the Experimental Life* (*286*). A particularly comprehensive array of factors are drawn up to show how consensus was attained. These include: material technologies, methods of communication ("literary technologies"), methods of assessment of experimental claims ("social technologies"). There are, too, a variety of interests playing a role in the attainment of consensus outside the immediate circle of pump operators such as interests in the integrity of experimental natural philosophy; interests in the proper places of public performance; interests in the expansion or preservation of existing disciplines; interests in the conservation of moral, religious, social and political beliefs and institutions etc. (*210*, 180). My own work does not attempt to draw up such an exhaustive list of all possibilities involved in the consensus of the area of early Romantic science it treats. But it does, I hope, provide some essential groundwork for such an exhaustive approach. It is also argued that, within the present state of scholarship on Romantic science, issues of practice are in need of analysis.

The intentions of this work, although also interdisciplinary, are from the outset different to the tenets of interest theory. This thesis's emphasis on the literary and the scientific drove me, firstly, into finding their links at fundamental levels, and to work downwards from the Romantic urge for unifying to find a common philosophical base. The thesis, then, set out to find instances where the unifying urge congealed into practical and concrete examples. A weakness of interest theory, as Jardine points out, is that "whereas agents' claims about the roles of rationality, reliability, calibration, proof, fact etc. in the formation of their beliefs are suspect, being likely to belong to the secondary mechanism of legitimation, their claims about the roles of interest may be taken on trust" (*210*, 183). This means "that many of the declarations of interest assigned by sociologists to the primary mechanism of consensus formation belong in fact to the secondary mechanism of legitimation of already formed consensuses" (*210*, 184). My own interest in the common base for the literary and scientific works of the Romantics is an attempt to clarify some of the particularly significant primary mechanisms of consensus in Romantic science. In this way I illustrate primary epistemological factors in knowledge formation which form the base for the social use of knowledge. Thus, a major notion treated in this present study, the early Romantic concept of natural philosophical productivity, is epistemologically based, but socially extendable.

*4. Novalis's notion of "experiment" and the issues of practice in the context of early Romantic natural philosophy.*

Before embarking on the discussion of practice and the genre of "experiment", and the further issues of genre concerning Romantic natural philosophical works, it is appropriate now to briefly state under the following ten key points what "practice" means in the context of this work.

Firstly laboratory practice is accounted for in a straightforward sense in the analysis of Ritter's work on galvanism.

Secondly, knowledge is viewed in terms of practice as something experiential. Particular examples of this form of knowing are concrete thought, symbols and visual thought. Novalis's notion of "experiment" refers both to literal laboratory experiments, thought "experiments" and the unity of both in inquiry. As will be shown, this notion of experiential knowledge forms a substantial part of early Romantic aesthetics in scientific inquiry.

Thirdly, Nature is treated as practical knowledge in the sense that it represents the embodiment of purposive forces.

Fourthly, the notion of practice, as interpreted in early Romantic natural philosophy, means that there is no question as to whether knowledge stems from experience or whether it is possible to attain knowledge prior to experience since knowledge is phenomenal and Nature in her purposiveness is "theory" herself. As stated in the third point, from the early Romantic perspective as here understood, Nature is living theory. Knowledge and phenomena are one and the same entity. Schelling's natural philosophy, too, is concerned in this way with the links between mind and matter, and strives to form the philosophical base for such an undertaking. Clearly, the early Romantics discuss the *a priori* in the light of Kant's philosophy, and like Kant, they are concerned with the limits of knowledge, but, unlike Kant, they problematize areas which Kant would have deemed too speculative (see below, p.64). Schelling's meaning of "das Absolute", as is discussed below, refers to absolute experience, which is the entirety of knowledge and purposiveness in Nature. Schelling, like Novalis, seeks to find the premises of such knowledge. When speaking of the absolute Schelling indeed refers to the *a priori*, but this cannot simply be equated with experience-free knowledge: instead, Schelling, as Novalis, is referring to a higher form of empiricism and experiential knowledge. Manfred Frank has shown how both Novalis and Schelling are concerned with paths to the absolute. Frank has stressed the notions of time and temporality in their thought, and this can be interpreted as their concern for experience itself (see below, pp.131 f.). Furthermore, the way the Romantics treat experience and *a priori* knowledge should always be seen in the light of the attempts to develop, refine and test the reliability of their methods. In this sense the creation of the *a priori* is always stressed as experiential and as an activity.

The fifth point is that the early Romantic research programme cannot be simply defined as following, for example, an organic or morphological paradigm in distinction to the mathematical paradigm. The Romantic programme has aspects which point to the holistic and universal laws of morphological inquiry, but, equally, work such as Ritter's shows that the Romantics made real contributions to mainstream science. Ritter's work on galvanism is deeply concerned with forms in a morphological sense, and, importantly, aims to approach morphology in a way which has quantitative characteristics. His work blends aspects of a quantitative approach with qualitative elements into physics. Furthermore, within the Romantics' concern for the universal also lies, inherent in their notion of the practice of knowledge, their concern for experimenting with and adapting systems of thought. Their understanding of universal laws is by no means reductive or dogmatically all-encompassing.

The sixth point is that the "speculative" elements of early Romantic natural philosophy such as their ideal types or archetypal phenomena were never meant to form unbending principles of a natural philosophical doctrine. Due to their philosophy of practice, such types are employed as open-ended concepts and are meant to be employed in further inquiry.

The seventh point puts some historical perspective on the previous ones. Here, practice refers to the teachings of Plotinos. Novalis was the first to rediscover Plotinos for the Romantics (*218*, 28) and uses him explicitly to define his notion of practical knowledge. In Plotinos Novalis sees the source of an enduring tradition of practical knowledge which finds its epitome in Goethe's scientific works (*N*, 3, 469). It is not only Plotinos's Neoplatonic ontology that is of interest to the Romantics - i.e. the notion of continuity in his emanations - but also, importantly, his notion of knowledge itself (as will be shown the former is, in any case, linked up to the latter). In the present work, Plotinos's notion of knowledge is understood in terms of practical knowledge and the practice of ideas. Lovejoy has extensively traced the significance of the idea of the Chain of Being, and he dedicates a section in his work to the subject of the temporalization of the notion of the Chain of Being during the eighteenth century (*238*, 242-287); in the course of this dissertation the ideas of temporality and the Chain of Being will be related to the early Romantics' concern for "experiment" and practical knowledge. Thus, it will be argued that Goethe and Novalis find important sources for their concepts of concrete, experiential knowledge both in Plotinos, and also in Herder's Plastik. Herder, importantly for the early Romantics, concerns himself with the notion of continuity (*249*, 8) as well as with experiential thought. Indeed, to Heinroth's description of Goethe's style of thought as "gegenständliches Denken", or Wolf von Engelhardt's and Dorothea Kuhn's reference to Goethe's "anschauenden Begriff", "zarte Empirie" or notion of "ahnden" (*169*, 228, 240), one can add Plotinos's concept of "Betrachtung". This term was used by Friedrich Creuzer in his 1804 translation of a part of Plotinos's works to impart the idea of active, "living" thought, and Goethe found it appealing to his own way of thinking (*218*, 29-30). Adler, too, has pointed to the influence of Plotinos on Goethe's notion of the "idea":

> Nach Goethes Verständnis verschmelzen in der "Idee" "eidos" und "idea", d.h. äußeres und inneres Anschauen. Dies durch Plotins Ideenverständnis vermittelte Konzept verhinderte bei Goethe eine rein metaphysische Interpretation der "Idee". Die "Idee" ist auch äußere Anschauung ("eidos")" (*129*, 19).

Furthermore, although I treat the early writings of Schelling where Neoplatonic influence is a factor (*165*, 82-82, 86-87), Schelling himself comes to an awareness of the epistemological significance of Plotinos later in 1805 (*218*, 28). This is not to say that Schelling does not concern himself with such an approach to epistemology earlier: indeed, as is argued in this introduction, elements of such an approach are present in his earlier writings up to 1801.

To conclude these initial comments on Plotinos: my work found much of its inspiration for its approach to Neoplatonism in Frances Yates's ground-breaking work *The Art of Memory* (*299*). Yates's analysis of the tradition of memory systems can, arguably, be read in terms of experiential thought and the practice of ideas. Yates ends her work with reference to the links between memory systems and Leibnitz's notion of "Combinatorik". In what follows, we will find in Novalis's own notion of "Combinatorik" an attempt to link the tradition of experimental philosophy with a stance to acquiring knowledge that bears similarities to Yates's interpretation of the manner in which ideas are treated by the Neoplatonists.

The eighth point, like the seventh, adds historical perspective to the others. Intellectual history of the past decades, in its various forms, has been deeply concerned with practice. The main thrust of this work moves away from the common sociological, literary or linguistic approaches in intellectual history to one more concerned with specific epistemological and aesthetic approaches, as manifest in the concerns of the early Romantics themselves. Language, however, does not remain untreated. This work can be seen as arguing with Manfred Frank for the particular role of language in German Idealism, and for the distinction between itself and the notions of language found in Structuralism and Deconstructionism. Frank argues for the role of the subject in language, as when he remarks:

> Signification has a certain leeway with regard to how it is disposed; it is always inscribed anew - to be sure, within reasonable limits - by individuals into the "mark" and has, as Humboldt says, "no permanent place even in writing" (*170a*, 408-409).

This view of language stresses both the role of the subject in interpreting signs and the flexibility of language - which stands between a reductive view that words have no meaning in themselves and the view that words can mean anything. Frank's views are of importance in defining the symbolic, "active", phenomenal nature of early Romantic views of language.[9] As already indicated, this work can be seen as extending Frank's view of early Romantic thought to the Romantic notion of scientific and natural philosophical productivity (see below, pp. 131 f.). However, as stated, the main concern of this work lies more in notions of practice than with language, although language necessarily is drawn in to the discussion. Reference is made in this introduction to the current debate on practical and tacit knowledge. Notions of practical knowledge are worthy of study in their own right, and even more so in the case of the early Romantics where practical knowledge operates in conjunction with the attempts to formulate systems of nature and the attempt to find reliable methods of knowledge formation over a broad spread of disciplines.

This work is concerned with the "reconstruction" of theory in Dewey's sense. An attempt is made to uncover not the formal theory or doctrine, but the inner or "working logic" (Dewey, Toulmin) of early Romantic forms of knowledge. This task is naturally undertaken by analyzing and re-presenting early Romantic practices. Thus there are thoroughly hermeneutic aspects to this work, as there are, too, in the notion of practical knowledge itself, since practice concerns individual knowledge. In its concern for practice this work is accordingly concerned, as Janik remarks on practice, with what "could be described epistemologically with Kant as the condition of the possibility" of a practice at all, or with what Collingwood calls the "absolute presuppositions" of practice (*208*, 52-54). For the early Romantics, the notion of ideal types and their method of knowledge formation in their natural philosophy are argued to be their "absolute presuppositions". Their natural philosophy is, as will be seen, not based upon doctrines, but upon factors concerning individual practice.

Within the context of the significance of individual practice to the Romantics it should be noted that the auto-experimentation or self-experimentation of the Romantics is not dealt with here. Clearly, their experiments on their own bodies are ripe material for a notion of individual knowledge and the role of the subject in inquiry. Humboldt's galvanic experiments on his back, Ritter's investigation of polar effects of galvanism on his own eyes, and Goethe's self-experiments in the physiological part of his *Farbenlehre* are all signs of the concern for experiential knowledge. Goethe's physiological work indeed is a concern of a later scientist such as Johannes Müller (a pupil of Helmholtz). This aspect of early Romanticism is important for defining notions of tacit, sensual and experiential knowledge, and, indeed, approaches the theme of "dangerous knowledge". None the less, I wish to concentrate not so much upon knowledge acquired from the senses alone (as in the literal experimentation on one's own body) but rather on the notion of sensual thought, and on linking this aspect of activity with aesthetics and knowledge formation. This area of research in itself makes a contribution to understanding and reassessing the Romantics; for their fundamental experimental and methodological concerns are in need of clarification.

The ninth point concerns practice in the sense of ethics. This work treats, in the main, the epistemological elements of the Romantic philosophy of practice, but these are bound up with, and form part of, ethics. This area of Romantic thought is arguably of great significance today to debates on ethics in science. This thesis provides definitions of Romantic thought on knowledge formation in discovery processes and in their attempts to construct systems of natural philosophy. In these definitions lie material for interpreting some aspects of ethics in the sciences. However, because of the need to define and delineate notions of knowledge formation as a subject matter in its own right, this work does not analyze the strict ethical notions of German Idealism, as arise in Kant's, Fichte's, Schelling's, and indeed, Novalis's works. Clearly, this area of German Idealism has already been extensively traced;[10] none the less the relationship of German Idealism's ethics to knowledge formation still largely remains an open area of study.

The tenth point concerns the distinctions in, and the purposes, and significance of early Romantic natural philosophy's concern for practice. Novalis's notion of practice is more embracing than that of Kant and Schelling. Kant is wary to keep practical knowledge apart from strict scientific methods (although in his *Kritik der Urtheilskraft* he does broach the issues of aesthetics and morals in the sciences - but not as intimately as is the case with Novalis and Schelling). Schelling, in his *System des transcendentalen Idealismus*, halts ostensibly at drawing an analogy between knowledge formation in general (i.e. in his tracing of the developmental "epochs" of the "Ich" - a process which is also linked to artistic methods of production) and Nature's own "epochs" of development, without making reference to natural philosophical-scientific methods of production (although it is importantly argued below that Schelling tacitly offers significant statements on natural philosophical-scientific methods of production in his *System* and elsewhere). Novalis goes further in terms of unifying knowledge by offering us a stance from which practical knowledge, ethics and science can be seen as one form of thinking in his encompassing notion of "experiment". Clearly, however, Schelling's natural philosophy has in itself, through its volume and breadth, much to offer the sciences in terms of philosophical orientation, and his philosophy did play a role in the development of the sciences. Moreover, Schelling's continual development of his natural philosophical systems does undoubtedly concern issues of practical knowledge, since he was attempting thereby, like Novalis, to find a reliable natural philosophical method. Schelling was, too, concerned with the experimental validity of his ideas and the link between his natural philosophy and strict empirical inquiry. In comparison to Schelling, Novalis's work is far slighter and he composed no system of natural philosophy, but there is a wealth of material concerning the activity of systemizing itself. The latter aspect of his work was due to his chief concern for a reliable method and his interest in practical details. However, in contrast to Schelling, Novalis had no direct effect on the sciences. But, it is argued in this work that Novalis had an influence on the sciences via Ritter, and in this indirect way, his effect on the sciences can be interpreted as significant. I show that Novalis and Ritter had much in common; but I do not go so far as to study the influence of Novalis's aphorisms on Ritter: that is a subject of further study. None the less, I hope that this work forms a significant base for such an investigation. In addition, Novalis and Schelling can be seen as complementing one another in ways which lead to a fuller and more coherent picture of early Romantic natural philosophy: where Novalis elaborates on aesthetics, practical knowledge, modes of systemization, and on the needs and practices of individual inquiry, Schelling develops a comprehensive system and methodology of natural philosophy designed to cover an exceedingly broad range of factors concerning many areas of the sciences. Furthermore, what Schelling states on philosophy and aesthetics, when seen in terms of knowledge formation, is also of great relevance to a notion of practice, and hence, also to the sciences, as will be argued below.

Finally, the figures of early Romantic science under discussion here, such as Goethe, Novalis and Schelling, have in general much material to offer current debate over the status of theory. Through its analysis of Romantic notions of practical knowledge this work attempts to fend off the relativism sometimes found in present debate over intellectual history. Systems theory, for example, as Halliburton points out, has now developed social systems to such an extent "with unprecedented power and exhibiting not only unprecedented complexity of organization but unprecedented flexibility and resourcefulness" (*182*, 87). Systems theory is capable of soaking up "almost anything" and also of becoming ever more complex and resourceful (*182*, 88). Literary or genre theory, on the other hand, runs the danger, of reducing thought to literary form or treating it exclusively in terms of semiotics. Derrida's work goes further in attacking any approaches to literature where the explanation "is a formalist one, in terms of semiological structures, or a "thematic" one, in terms of, say, Marxist or Freudian theory" (*187*, 20). The problem of all of these discourses, as Halliburton states, is firstly that their "noise" endangers proper communication, and secondly, that "the question of ends seems indefinitely deferrable" (the latter point particularly refers, in Halliburton's view, to deconstructionism) (*182*, 74-75). Moreover, Derrida, as Shaffer has argued, runs the danger of blocking off any chance of reinstating the value of free rational inquiry. It is particularly in Derrida's assault on Kant's role in the shaping of the modern university that Shaffer finds due cause for concern: in undermining the Enlightenment reason of Kant, Derrida "attacks reason in its citadel: in Kant he attacks the greatest philosopher of modern times, attacks him in the act of making a programmatic statement of the powers and duties of free rational inquiry" (*280*, xx). This work argues strongly against any relativism such as Derrida's, and, as far as Kant is concerned, this work is at pains to show that although the Romantics do differ from Kant, their thought is in many ways an extension of Kant's. Kant, in fact, was their legitimizing springboard for a variety of views (see below, pp.64-67). If the Romantics, in going beyond Kant and in their unifying urge, are interpreted as tending towards the relativism of open-ended theory, then this work argues that their concern for practice (the means of attaining knowledge) puts reigns upon this tendency, and, indeed, sets concrete precedents (the outcomes of their inquiries) within their encompassing natural philosophical outlook (their absolute goals or theoretical ends). It is their "working logic" and experiential approach to thought that keeps relativism at bay.

The issues of practice for the Romantics will now be traced in detail. Initially I will concentrate on Novalis's remarks on methodology, and the early natural philosophical works of Schelling up to 1801, before moving on to other Romantic thinkers. In Schelling's highly programmatic work of 1800 - programmatic for his notion of natural philosophy - *System des transcendentalen Idealismus*, Schelling is primarily concerned with setting the bounds of natural philosophical knowledge. In this sense, the work lies squarely in the "critical" tradition of German Idealism. For here, Schelling constructs the history of the "Ich", taking the "Ich" through its developmental epochs. He also constructs the moments of matter, and views matter's development as analogous to the development of the "Ich". Another of his major concerns is thus to show that man's development is part of Nature's development: this is his notion of natural history. Schelling's *System des* *transcendentalen Idealismus* is not a full blown natural philosophical system, nor does it, in essence, give guidelines for natural philosophical method. What Schelling does here is to draw analogies between philosophical production, the productivity of natural forces and aesthetic production. His tracing of the history (the "epochs") of man's knowledge, Nature's development of forces and aesthetic production can be read in terms of knowledge formation.[11] However, as will be discussed below, Schelling draws a sharp line between aesthetic production and philosophical production (in the latter scientific production is also implied). In the great task of drawing up his analogies between the development of the "Ich", matter, and art, and in his wish to state the objective primacy of aesthetic production, the natural philosophical elements of scientific production are not fully presented. In distinguishing between philosophical (as mentioned, implied here is also scientific production) and aesthetic production, Schelling ostensibly leaves little space for aesthetics in scientific production. Naturally, his very act of drawing analogies between philosophical, scientific and aesthetic production provides vital clues as to how aesthetics can be employed in scientific production. In three ways it will be shown that Schelling's early natural philosophical thought can be read in terms of the aesthetics of natural philosophical-scientific production: firstly, in his notion of experiential knowledge and knowledge formation, secondly, in the implications of the analogies he draws between modes of production in different realms, and thirdly, in his notion of "Zwischenglieder".

Novalis, from the very start of his natural philosophical thought, is directly concerned with natural philosophical production and the aesthetic elements therein. It is perhaps Novalis's stance here that leads him to remark in 1800: "Was die Schel[lingsche] Nat[ur] Phil[osophie] eigentlich sey?" (*N*, 3, 666). Although Novalis, like Schelling, was concerned with setting the bounds of natural philosophy, he was clearly hoping for more explicit material from Schelling on natural philosophical production, practice and method. Novalis proposes a method for the sciences which is most aptly summed up in his remark calling for a "Philosophische Geschichte der Entdeckungen" (*N*, 3, 86). Novalis believed that the history of discovery processes, i.e. our methods of discovery in the sciences, would reveal the history of Nature herself. Elsewhere he remarks: "Der Geisterwelt gehört das erste Capitel in der Physik" (*N*, 3, 601). With both of the above statements Novalis is referring to the same purposive force that gives rise to the activities, "method" and processes of man's intellect and phenomena. Firstly, Novalis is stating that what man undertakes in inquiry is a part of the history of Nature itself. Secondly, Novalis is making the point that the beginnings of science belong to the realm of ideas and spirit. To discuss final causes in Nature necessarily entails the evocation of a first purposive force. The study of Nature's purposiveness is, to Novalis, the study of Nature's own "method". Analysis of Nature's "intelligent" formative forces allows Novalis to see the development of phenomena as the process of Nature's own formation of knowledge. To Novalis, purposive processes imply that intelligence, i.e. knowledge, is at work. Following on from these ideas, Novalis further implies that in discovery processes it is possible to perceive the original purposive force at work. This is so, in Novalis's view, because during this process man is intimately linked to Nature. In investigating natural phenomena and discovering Nature the inquirer enters into a close dialogue with phenomena, and it is this moment of dialogue, the mediation and interplay between the inquirer and the observed, that is the point when the inquirer is closest to Nature's secrets. It is not alone in the finally attained theory that the inquirer comes to understanding Nature, it is rather that this understanding essentially takes place in the actual process of inquiry itself. Novalis argues that the process of inquiry is directly linked to the processes under observation. If the inquirer succeeds in hitting upon a key principle of Nature he will come closer to the phenomenon by empathizing with it. It is in this act of empathy that the inquirer "absorbs" the phenomenon, retracing the phenomenon's own being and activity. In this way Novalis remarks that the inquirer should have an inner sense for Nature:

Zum Experimentiren gehört Naturgenie, d.ist, wunderartige Fähigkeit den Sinn der Natur zu treffen - und in ihrem Geiste zu handeln. Der ächte Beobachter ist Künstler - er ahndet das Bedeutende und weiß aus dem seltsamen, vorüberstreichenden Gemisch von Erscheinungen die Wichtigen herauszufühlen (*N*, 3, 179).

The inquirer should retrace Nature's activities using the power (i.e. "virtue") of his own sense for Nature. How Novalis justifies this view will now be delineated in more detail.

For Novalis and Schelling, time and history themselves point to the notion of method. Since they view knowledge as a process, knowledge is seen as history in the making. This type of history is primarily concerned with "how" things come about and "how" we arrive at knowledge rather than with "what" we know about objects. Schelling's philosophy above all aims to provide guidelines for a "construction" of Nature, i.e. the explanation of how knowledge and purposiveness come about within Nature as a whole. Similarly, Novalis is concerned with the "how" of natural forces and "how" scientific theory comes about in discovery processes. The question of how history occurs is a prerequisite to any portrayal of history itself: to them history can only arise out of a proper method.

Important to the debate on method are Novalis's and Schelling's notions of practical knowledge. The discussion on method involves the resolution of theoretical and practical activities in inquiry. Within this field the notion of "experiment" is particularly useful in defining the philosophical parameters. To experiment by no means implies a testing of a given theory, nor is the act of experimentation a direct form of induction from natural phenomena, or, even more crassly, a direct deduction of theory from the given phenomena under investigation. Direct induction or deduction from phenomena are methodologically impossible since any inquirer is always to some extent theorizing with nature, i.e. the inquirer always comes to phenomena from a particular theoretical stance. Inquiry involves a definite mediation between theory and phenomena. Novalis concerns himself intensively with the notion of "experiment" and he uses the term "experiment" to mean both the testing of experience and the testing of ideas. In his notion of testing ideas or knowledge itself Novalis proposes that our way of forming knowledge should be put under closer scrutiny. In essence Novalis is concerned here with avoiding the rift between the inquirer and natural phenomena. The problem of this rift is indeed a subject of current interest and has led historians of science to suggest that today's science is often only involved in the testing of theory and no longer directly tests nature itself (*177*, xiii, 14). Novalis's solution to this problem lies firstly in his notion that knowledge is something experiential itself and, secondly, in his proposal of a method of inquiry that works outwards from phenomena. In his notion of experiential knowledge Novalis makes the distinction between formal, analytical knowledge and a type of knowledge that mediates between theory and phenomena. In order to mediate between theory and phenomena Novalis proposes the use of representative symbols of the imagination. Within his notion of a scientific method, representative symbols are taken by Novalis to mean those powerfully laden empirical notions which are attained by our perception and knowledge of particularly significant phenomena themselves.

However, before discussing representation, the notion of experiential knowledge should be treated in more detail. One of Novalis's sources for his view of experiential forms of knowledge is Herder. It is from Herder's *Plastik* that Novalis obtains the view that the inquirer is capable of having a "feeling" ("Gefühl") for ideas. Herder plays upon the two meanings of "Gefühl", that literally of the senses and that of an inner sense (*294*, 34). Herder's reasoning behind this viewpoint lies within the notion, as he remarks, that it is a "Metaphysisch- und Physisch erwiesener Satz, daß nur körperliches Gefühl uns Formen gebe" (*52*, 71). Herder directly links sense perception to "the mental activities of knowing, feeling and willing" (*294*, 36). It is this experiential approach to thought that gives justification to Novalis's notion of "experimental" knowledge. Having a "sense" or "feel" for ideas implies that ideas can be experienced. When Novalis speaks of the use of representation in inquiry he thus refers to those ideas and concepts that can be "felt". In the present context of the term "experiment", it is important to note that Novalis refers to representation through his notion of the "Plastisirungsmethode" or its synonym the "Experimentalmethode" (*N*, 3, 123). To Novalis, genuine "experimenting" requires a secure experiential knowledge of the concepts and of the phenomena under observation. In this way the rift between theory and nature is to be resolved since theory has to be firmly rooted in experiential knowledge: theory should not be allowed to drift away from nature, and knowledge itself is viewed as a phenomenon that can be experienced. The ability to "experiment", in Novalis's view, involves an array of skills and experience in handling phenomena. Such skills entail the development, simplification and combining of experiments. Novalis stresses too the ability to select and order phenomena according to a "taste" or "sense" for Nature ("Naturgeschmackvolle oder Natursinnreiche Auswahl und Anordnung"). Last, but not least, "experimentation" also requires the ability to represent phenomena, both exactly and synthetically:

> Der ächte Naturliebhaber zeichnet sich eben durch seine Fertigkeit die Experimente zu vervielfältigen, zu vereinfachen, zu combiniren, und zu Analysiren, zu romantisiren und popularisiren, durch seinen Erfindungsgeist neuer Experimente - durch seine Naturgeschmackvolle oder Natursinnreiche Auswahl und Anordnung derselben, durch Schärfe und Deutlichkeit der Beobachtung, und artistische, sowohl zusammengefaßte, als ausführliche Beschreibung, oder Darstellung der Beobachtung aus (*N*, 3, 256).

To conclude with the significance these experimental skills have for Novalis's notion of experiential knowledge: one can say that the act of experimentation is, to Novalis, the literal viewing of theory in phenomena, or to state this point otherwise, experimentation is the experiencing of theory within phenomena. This act of knowledge is quite different to the testing of a theory alone, for Novalis demands a specific closeness to phenomena, both in our experiential knowledge of phenomena and in our skills in working with phenomena. It is this specific proximity to phenomena and "feel" for Nature which, in Novalis's view, allows for a more precise and comprehensive rendering of Nature.

Schelling, too, proposes a similar experiential approach to knowledge formation in his *Einleitung zu dem Entwurf eines Systems der Naturphilosophie*. There Schelling states that all knowledge stems from experience:

*Wir wissen nicht nur dieß oder jenes, sondern wir wissen ursprünglich überhaupt nichts als durch Erfahrung, und mittelst der Erfahrung*, und insofern besteht unser ganzes Wissen aus Erfahrungssätzen (*109*, 278).

Schelling further defines there what he means by *a priori* knowledge, and it is importantly not formal-theoretical knowledge. To Schelling *a priori* concepts are those concepts gained from experience which are "necessary" ("nothwendig"). He explains his notion of experiential principles ("Erfahrungssätze") in the following way:

Zu Sätzen *a priori* werden diese Sätze nur dadurch, daß man sich ihrer als nothwendiger bewußt wird, und so kann jeder Satz, sein Inhalt sey übrigens welcher er wolle, zu jener Dignität erhoben werden, da der Unterschied zwischen Sätzen *a priori* und *a posteriori* nicht etwa, wie mancher sich eingebildet haben mag, ein ursprünglich an den Sätzen selbst haftender Unterschied, sondern ein Unterschied ist, der bloß in Absicht auf unser Wissen und die Art unseres Wissens von diesen Sätzen gemacht wird, so daß jeder Satz, der für mich bloß historisch ist, ein Erfahrungssatz, derselbe aber, sobald ich unmittelbar oder mittelbar die Einsicht in seine innere Nothwendigkeit erlange, ein Satz *a priori* wird (*109*, 278).

Schelling is remarking how *a priori* knowledge comes about, namely in a process stemming from experience. Thus, Schelling's goal, like Novalis's, is not to approach knowledge from the formal-theoretical but above all from the experiential. Naturally, experiential knowledge here does not refer to plain empiricism, nor to Hume's notion of empirical knowledge, but to a distinct notion of experiential knowledge that can only be valued within the whole framework of Schelling's natural philosophy. Schelling's greater goal in his natural philosophy is to find the principles that lie behind natural phenomena. In Schelling's view, since Nature is an organic whole within which the parts stem from an original *a priori* principle, it should be possible, by finding the necessary ("nothwendig") principles, to "construct" a view of the nature.[12] Schelling remarks:

Die Einsicht in diese innere Nothwendigkeit aller Naturerscheinungen wird freilich noch vollkommener, sobald man bedenkt, daß es kein wahres System gibt, das nicht zugleich ein organisches Ganzes wäre. Denn wenn in jedem organischen Ganzen sich alles wechselseitig trägt und unterstützt, so mußte diese Organisation als Ganzes ihren Theilen präexistiren, nicht das Ganze konnte aus den Theilen, sondern die Theile mußten aus dem Ganzen entspringen. Nicht also wir kennen die Natur, sondern die Natur ist *a priori*, d.h. alles Einzelne in ihr ist zum Voraus bestimmt durch das Ganze oder durch die Idee einer Natur überhaupt. Aber ist die Natur *a priori*, so muß es auch möglich seyn, sie als etwas, das *a priori* ist, zu erkennen, und dies eigentlich ist der Sinn unsrer Behauptung (*109*, 279).

It is within the context of the notion of an *a priori* purposive Nature that Schelling refers to the paradoxical sounding notion of necessary and *a priori* experiential knowledge. When Schelling refers to the absolute he refers to the totality of knowledge and purposiveness expressed in Nature's activities as a whole. When Schelling speaks of the *a priori* he is searching for the absolute premises of knowledge, as visible when he remarks that "alle Erscheinungen in Einem absoluten und *nothwendigen* Gesetze zusammenhangen, kurz, daß man in der Naturwissenschaft alles, was man weiß, absolut *a priori* wisse" (*109*, 276-277). Such *a priori* knowledge has the status of the evidential "Das Evidente und Gewisse" (*109*, 279). In this light the *a priori* cannot be interpreted simply as experience-free knowledge: instead in the Romantic search for the evidential premises of the *a priori* they are seeking the fundamental premises and boundaries of total experience. Thus it is, too, that Schelling refers to the creative act of experimentation ("Prophezeiung"), which is an act that has to employ the "Construktion" of "speculative Physik" (*109*, 276, 280). Schelling points out that discrete empirical experimentation is not enough in itself, since the experimenter must bring the powers of the subject to his aid, otherwise the experimenter will never find his way beyond the phenomena he is investigating: Schelling thus implies that an experiment in this sense will never escape the regress of unreflective empirical investigation of phenomena "daß es [*das Experiment*] nie über die Naturkräfte, deren es sich selbst als Mittel bedient, hinauskommen kann" (*109*, 277)). Thus it is that the subject role's in Schelling's "speculative Physik" is that of a mediator between plain induction and scientific theory. It is through this mediation that true experimentation is made possible in Schelling's view:

Es ist daher begreiflich,daß *speculative* Physik (die Seele des wahren Experiments) von jeher die Mutter aller großen Entdeckungen in der Natur gewesen ist (*109, 280*).

It is important to note that although Schelling refers to the absolute principles of knowledge, his own natural philosophical works show that this is his goal, but that, in practice, Schelling is continually searching for the boundaries and likelihood of such absolute principles, and that there is a considerable amount of change in, and reassessment, of such principles in his natural philosophical endeavours.[13]

Schelling seeks to resolve the perennial problem of mind against matter by viewing man's knowledge as part of the purposive organic whole of Nature. Indeed, Schelling's concept of the "Ich" directly promotes the idea that man's knowledge is evidential: "Ich bin! Mein Ich enthält ein Sein, das allem Denken und Vorstellen vorausgeht" (*105*, 167; *273*, 246). In his notion of the intuition ("Anschauung") Schelling argues that man is capable of intuiting the key forces and phenomena in Nature. In the act of intuiting man creates Nature for himself, he constructs phenomena (*244*, 30). In the way the intuition can seek out and select significant phenomena the inquirer can arrive at necessary, evident and *a priori* knowledge. It is in this way that Schelling speaks of experiential knowledge within his natural philosophy. This form of experiential knowing is not a purely objective knowledge of empirical phenomena, instead it is part of the whole creative process of Nature: it is part of Nature in the making, and, as has often been remarked upon, the act of the intuiting is concerned with the process of "natura naturans" and not the state of "natura naturata" (*221*, 114). In the context of "experimentation", Schelling states that it is the task of natural philosophy to supply the empirical scientist with the necessary evidential principles with which to conduct experiments. With this in mind Schelling defines the notion of "experiment":

Jedes Experiment ist eine Frage an die Natur, auf welche zu antworten sie gezwungen wird. Aber jede Frage enthält ein verstecktes Urtheil *a priori* (*109*, 276).

"Experimentation", in Schelling's view, is the creative act of constructing Nature with the proper evidential principles. In the act of construction Nature is "brought forth":

Jedes Experiment, das Experiment ist, ist Prophezeiung; das Experimentiren selbst ein Hervorbringen der Erscheinungen (*109*, 276).

Consanguineous with Schelling's view is Novalis's belief that the inquirer should seek out "wircksame Begriffe" to inquire into natural phenomena. As the concept of "wircksame Begriffe" implies (i.e. "effective", literally physical concepts pertaining to force and matter), Novalis seeks certain key experiential notions as a basis for inquiry. Both Novalis and Schelling thus advocate a type of philosophical empiricism. Novalis gives this form of inquiry a name: "thätiger Empirismus" (active empiricism) (*N*, 3, 445, 600). Active empiricism refers at one level to the experiential nature of ideas and the way our perception of phenomena involves mediation between theory and phenomena. In this process of mediation ideas obtain a form of physicality as the terms "thätig", "wircksam" and "Plastisirung" suggest. "Thätiger Empirismus" also refers to the whole of Nature in the way it suggests that Nature operates according to fundamental purposive principles. In finding a method that remains close to experience the inquirer retraces Nature's own forces. Nature's purposiveness needs to be matched by an adequate method, and this is why the "philosophical history of discoveries" is brought into discussion by Novalis. Like Schelling, Novalis sees a purposive structure in Nature which is analogous to the purposiveness of human consciousness and thought.

Both Novalis's and Schelling's views on knowledge go a considerable way beyond Kant. It can be said that much of what Kant intimates (in the realms of natural philosophy, aesthetics and ethics) is then realized by the Romantics, or to put it otherwise, much of what Kant deems regulative for aesthetics and natural organization becomes constitutive for Romantic views on knowledge and phenomena. Clearly, Novalis's and Schelling's views of knowledge owe much to Kant. Without Kant's reassertion of the subject they could not have developed their own critical apparatus. Equally, Novalis and Schelling are, as is Kant, concerned with the absolute premises of knowledge. Furthermore, Kant's notions of aesthetic and teleological appraisal in his *Kritik der Urteilskraft* treat the ordering of nature in terms of perception, the imagination and understanding: such an approach has many parallels to Romantic natural philosophical endeavours.[14] In addition, Kant's notion of judgement, with its emphasis on the process and practice of, as opposed to the formal use of judgement, shares the concerns of the Romantics for experiential, concrete knowledge.[15] None the less, Schelling's "Anschauung" and Novalis's notion of "Plastisirung" give knowledge an ontological base in a way that Kant's notions of knowledge in his *Kritik der reinen Vernunft* do not. By viewing knowledge as part of natural processes the rift between Kant's judgements and the world of the "Ding an sich" is overcome. Schmied-Kowarzik has pointed out how Schelling's notion of "Konstruktion" is quite distinct from Kant's, since Schelling begins with the assumption that our thought is part of the world of the "Ding an sich":

Für Schelling dagegen wird das Konstrukt der Welt von Dingen an sich jenseits der Sinnenwelt hinfällig, da wir mit der wirklichen Erfahrung immer schon bei den Dingen an sich sind (*274*, 77).

Kant does hold the opinion that knowledge begins with experience, but he does not back up this view with an ontology of nature in the way that Novalis and Schelling do. Importantly, Kant separates "Anschauung" from "Verstand", whereas thinkers such as Herder, Fichte, Novalis and Schelling place particular importance on the role of the "Anschauung" in knowledge formation. Furthermore, although Kant does indeed raise the notion of a "construction" of knowledge in his concept of "synthetische Urtheile *a priori*" (synthetic *a priori* judgements), this form of knowledge does not resolve the rift between our judgements and the the world of the "Ding an sich". Mathematical judgements and those implied in the regulative principles of reason ("Grundsätze des reinen Verstandes") of his own philosophy, according to Kant, do "construct" new knowledge (*166*, 194). Synthetic *a priori* judgements (through the assistance of "Schemata") do, to an extent, bridge the gap between experience and theoretical knowledge since they produce knowledge which is applicable to experience without being directly derived from experience itself. Synthetic *a priori* judgements do act as mediators between theory and experience, but within the context of the whole of Kant's philosophy they do not have the ontological significance that the Romantics see in types of knowledge that mediate between theory and phenomena. For one, Kant limits synthetic *a priori* judgements to mathematics and to the regulative principles of reason. Secondly, Kant is cautious about the extent to which we can gain proper objective knowledge of phenomena - only by respecting the limitations of our faculties is this possible, and it is within these bounds that Kant puts forward his view of valid objective knowledge. Admittedly, in his later critiques, Kant extends his thought, treating moral knowledge, and also the problems of the organic sciences, as for example, the use of morphotypes or organizational plans in comparative anatomy within the scope of a teleological framework (*235*, 122). However, precisely the type of capabilities related to the realms of the moral and of practice which Kant attributes to the human mind Novalis and Schelling wish to concede to scientific knowledge as well. Within a natural philosophy of science they see the possibilities of bridging the gap between man's thought and the world of the "Ding an sich". To do justice to Kant, one must state that, just as his earlier philosophy can be seen as setting strict limits to man's capability of knowing, and, also, as a justification of conventional Newtonianism, his views on dynamism and the organic can be seen as a crucial springboard for Schelling's natural philosophy (*164*, 25; *165*, 75-77; *221*, 113-114).

In his *Metaphysische Anfangsgründe der Naturwissenschaft* Kant puts forward a dynamic notion of matter based upon the forces of attraction and repulsion. Kant deduced this analytically by examining the *a priori* conditions of matter. Schelling accepts this but goes further to question the origins of the forces. Schelling argues that this can only be done synthetically by deducing the forces from the activities of the mind. This importantly provides the conditions for the possibility of the outer intuition ("Bedingungen der Möglichkeit der äußerer Anschauung") (*106*, 216; *165*, 74-75). There are, however, further substantial differences between Schelling and Kant, even though Kant's influence is visible. In his *Metaphysische Anfangsgründe* Kant divides the science of matter into four areas: "Phoronomie", the study of quantitative motion; "Dynamik", the study of qualitative motion; "Mechanik", the study of relative motion; and "Phänomenologie", the study of matter according to notions of motion and rest ("Modalität"). Schelling, in his *Ideen*, puts forward a physics based upon quantitative, qualitative and relative motions. In his notion of qualitative motion he introduces chemical aspects, and discards Kant's "Phänomenologie", whose task is taken over by chemistry. Whereas Kant rejects chemistry as being incapable of attaining the status of a science, Schelling positions chemistry above "Mechanik", and indeed views chemistry as the necessary fundament to mechanics, providing it with its contents and its various applications. Schelling thus converted Kant's mathematically oriented physics into a quite different entity (*259*, 53-55). Of further influence on Schelling, as mentioned, were Kant's notions of the organic and purposiveness in nature as expressed in his *Kritik der Urtheilskraft*. Kant's notions were developed considerably by Schelling in his *Von der Weltseele* (and in later works) into his idea of the "absolute" or "general organism", from which the conditions for the inorganic and the validity of mechanical principles were to be deduced (*165*, 76-77; *107*, 349, 500; *109*, 70, 326).

Kant's later views on knowledge and the sciences are more amenable to the Romantics than those in his *Kritik der reinen Vernunft* - even given the way a thinker such as Schelling considerably adapts Kant's views. However, putting these Romantic extensions of Kant's thoughts aside, the main issue here is to note the fundamental ontological difference between Kant and the Romantics, even though - from their perspective - Kant had in fact done much ground work for them. Novalis's and Schelling's views on the make-up of knowledge can thus be briefly stated in the following way: knowledge is a part of Nature, and like all phenomena knowledge is a process. Since acts of knowledge are part of the process of Nature they are experiential. Schelling's "Anschauung" and Novalis's "Plastisirungsmethode" are those acts of knowledge where man creates ("constructs") Nature herself. Both attempt to put forward models of an inner logic of knowledge (a "working logic") that are neglected by those who are concerned with formal, theoretical knowledge alone.

At this point a further analysis of the issues surrounding practical knowledge should be given so as to put both Schelling's and Novalis's thoughts into a greater context, reaching back to the ancients and up to the modern arena of this century. Such a broad contextualization has recently been undertaken by Jonsen and Toulmin, the authors of *The Abuse of Casuistry* (*211*). To differentiate between notions of theory and practical knowledge it is illuminating to look back to the tenets of Plato (427 - 348) and Aristotle (384 - 322). Whereas Plato stresses the formal perfection of geometry and the "episteme" (i.e. theory) in both science and ethics, Aristotle draws a line between the theoretical nature of scientific knowledge and the circumstantial nature of ethics (*211*, 62-63). Aristotle refers to theoretical science as "episteme" and he calls practical skills "technai". He introduces, however, a further notion to practical knowledge, that of "prudence" or "phronesis", and this plays a major role in his ethics (*211*, 37). "Phronesis" refers to practical wisdom gained from experience and the ability to deal with particular individuals and actual situations (*211*, 37). "Phronesis" involves human perception and judgement and is a very different capability to that of "episteme". Whereas the "episteme" of science operates according to "universal principles" and is deductive in nature, "phronesis" requires experience based judgements and the direct perception of "ultimate particulars" (*211*, 66). Aristotle states:

> In this respect, phronesis and episteme are opposed. The intellect masters the basic definitions of a science, which are not further demonstrable [and argues from these definitions]; but phronesis deals with the "ultimate particular" [to eschaton], and this is an object of perception [aisthesis] rather than episteme.[16]

It is important to note that "phronesis" is a higher form of experience than plain sensual perception. Aristotle compares the way "phronesis" picks upon ultimate particulars to the way a triangle is perceived in mathematics. The ultimate particulars are perceived not "by normal sense perception, to be sure; but in the kind of way we recognize that the triangle (say) is an ultimate element [eschaton] in mathematics".[17] Jonsen and Toulmin remark how "phronesis" thus operates according to "paradigmatic or type cases" (*211*, 66). The crucial point is that for "phronesis", unlike "episteme", no deductive proof is required to recognize that "a triangle is triangular", or in the realm of morals that "an act of cruelty is cruel" (*211*, 66). "Phronesis" is based upon the experiences the individual has made and provides "certainties of a distinct and distinctive kind" (*211*, 67). The form of knowing that Aristotle proposes through "phronesis" possesses similarities to Novalis's and Schelling's idea that man is capable of arriving at significant judgements through experiential knowledge, and also that paradigmatic types, i.e. open-ended concepts, are used to form knowledge. Clearly, however, Aristotle deems "phronesis" only suitable for ethics, whereas the Romantics sought to apply the sort of knowledge gained through "phronesis" to the sciences as well.

In this context it should be noted that - as mentioned earlier - Novalis finds his classic ideal not in Aristotle or Plato, but in Plotinos. Novalis sees in Plotinos's philosophical style a way of coming to knowledge that steered between the formal-theoretical and the concrete-experiential. Novalis finds in Plotinos precisely the sort of natural philosophical approach he himself espoused: a way of coming to knowledge that ontologically linked man's thought to phenomena. Plotinos's emanations and his notion of "Sympathie" provide Novalis with a model of natural philosophy that both explains thought phenomenally and provides a picture of a purposive natural world.[18]

There are, further, key issues ensuing from Jonsen and Toulmin's study that relate directly to modern notions of practical knowledge. It has already been noted that modern science contains the danger of an alienation from the world of experience: in many aspects science today is no longer in touch with the natural world but only with theory. Jonsen and Toulmin point out that in scientific theory today the general ideas, although not divorced from actual objects, "refer directly only to preselected objects, which exemplify them precisely enough to be relevant to the theory" (*211*, 30-31). Physicists concern themselves directly only with "circumstances and cases that are "abstracted" (i.e., selected out) as being relevant to their central theoretical goals" (*211*, 31). To illustrate this view Jonsen and Toulmin remark how the physicist studying gravity is directly interested in the movements of planets, but not in "the fluttering of a falling sheet of paper" (*211*, 31). The other factors effecting the fall of the sheet of the paper, such as air currents, cannot be separated in practice from the gravitational factors. Moreover, Jonsen and Toulmin assert that the scientific theory of the modern physicist may indeed not refer beyond the world of temporal experience, but, none the less, the theory seeks to state the atemporal, "covering all relevant cases, anywhere, at any time" (*211*, 32). This approach to science differs from that of Schelling and Novalis in three cardinal ways. Firstly, it differs from the Romantic concern for the experiential, and, secondly, it differs from the Romantic concern for the process of Nature, which is anything but atemporal since the Romantics are concerned with the process and change within Nature. Thirdly, when Novalis and Schelling select particular forces or phenomena, they do so in the belief that the chosen items are evidential, experiential and form part of a purposive whole of Nature.

Of relevance to the issues of practical or experiential knowledge is also the way in which Jonsen and Toulmin distinguish between the theoretical activities of the physicist and the practical knowledge of clinical medicine. They argue that medical diagnosis involves the use of a taxonomy of known conditions and the ability to classify the patient's condition in terms of "types" (*211*, 40). The method of clinical medicine works upon substantive as opposed to formal claims. The conclusion of the diagnosis in clinical medicine is viewed not as a necessary entailment of its findings, but as a "rebuttable presumption" (*211*, 42). The conclusion of the findings of clinical medicine is not atemporal, "but thoroughly circumstantial" (*211*, 42). The method of clinical medicine, whereby types of symptoms are linked with types of diseases, is altogether based upon analogical argument (*211*, 41). This approach to method, in its use of analogy and evidential types, is not dissimilar to the views of the Romantics. A further similarity lies in the open-ended nature of clinical medicine's "rebuttable presumptions" and the natural philosophical concepts of the Romantics. Novalis views phosphorus, for example, as a key symbolic concept within the pneumatic debate. Phosphorus, in Novalis's view, was both a key notion underlying much of the pneumatic debate, and also a key chemical notion for the furtherance of the debate: phosphorus was an open-ended concept, standing for a variety of theoretical viewpoints, and in this way was not limited to a single atemporal theory. Where clinical medicine and the Romantics most probably part is over the notion of circumstantiality. Novalis and Schelling do not see types in general (i.e. their notions and principles of natural philosophy) as purely circumstantial but as part of the greater purposive process of Nature. Their types transcend the temporal, but are not atemporal since they are part of the continuing process of Nature.

Pertinent to the analysis of issues surrounding the notion of practical knowledge, and recalling the example of Aristotle, it is of relevance that current debate over practical knowledge has also been directed at the philosophy of Ludwig Wittgenstein (1889 - 1951). Janik makes the point that Aristotle's ethics are based around the notion that the individual must learn practical wisdom in his or her own way. They must follow the examples (i.e. paradigms) set by others but interpret them individually (*208*, 51). Janik links Aristotle's ethics to tacit knowledge by alerting us to the fact that the practical wisdom conveyed by the person who is setting the example can only be transferred indirectly. Practical wisdom cannot be taught or expressed in terms of formal knowledge or rules. An exemplary action is an indirect way of passing on wisdom. Janik remarks that "hints and examples are vastly more important than formal rules" for the individual who strives to gain practical knowledge. He continues:

> In this sense practical wisdom is tacit knowledge, for it is genuine knowledge; the practically wise person "hits the mark" but the how is only indirectly communicable (*208*, 51).

Thus Janik sees Aristotle's concept of practical life resting "wholly upon tacit knowledge" (*208*, 51). This view of practical knowledge, since there are no formal rules, begs the question as to how exactly this sort of knowledge is then formed. The example above of the method of clinical medicine given by Jonsen and Toulmin is one answer. Another answer is found by Janik in the thought of Wittgenstein and the differentiation made between regulative and constitutive rules. To Wittgenstein it is impossible to formulate explicit, formal (regulative) rules which govern human behaviour. Language and meaning is constitutive of human behaviour, and "this means we can never get outside of it to observe it" (i.e. to produce formal rules on behaviour) (*208*, 52). In fact, as Janik points out, taking up Wittgenstein's line of argument, to follow explicit rules of behaviour is logically regressive:

> If it were necessary to have an explicit rule according to which we learn how to imitate, say, the dance teacher's step, we would also need another rule to apply to that rule and so on ad infinitum (*208*, 52).[19]

When one learns by example, be it from the dance teacher or from the sports coach, one perceives a certain type or model (a constitutive rule). The learning process involves the imitation of models (i.e. constitutive, open-ended rules): we learn analogically and "invent new ways of using old models" (*208*, 52). The analogical method of using constitutive rules explains why constitutive rules can contain both the knowledge of tradition and the seeds for innovation on the part of the learner. This explains why, as Göronzon has commented, Wittgenstein views concepts not as rules themselves:

> Wittgenstein perceives a concept as a set of activities that follow a rule, in contrast to regarding the concept as a rule ... In this way, the concept becomes related to its usage. The use of the concept determines its content. It is our usage or practice that shows the way in which we understand something (*178*, 10).

This analogical and experiential approach to knowledge gaining is also commented on by Novalis. He remarks that knowledge arises out of a productive use of tradition, and that the knowledge passed down by tradition is recreated anew by the learner:

(Aus der *Tradition* ist *Lehre* geworden) (Alle *Lehre* bezieht sich auf Kunst - Praxis). Man muß die Wahrheit überall vergegenwärtigen - überall *repraesentiren* (im thätigen, producirenden Sinn) können (*N*, 3, 445).

The truths of tradition are not followed as formal rules: the truths are seen as forms of practice themselves which in turn can only be understood by creative reenactment through their experiential "representation" by the learner. As already noted, representation refers to the notion of plasticizing or "feeling" ideas, and it is, according to Novalis, through a "feel" for the practical factors within a tradition, and not through formal rules, that one can best understand the knowledge within a specific tradition. Tradition offers the learner a wealth of experiential knowledge, an abundance of open-ended models and paradigms, which the learner can then innovate upon. It is in this sense that the natural philosophy of Novalis and Schelling seeks those aspects of phenomena and man's thought which form an inner logic of Nature. Both man and other natural phenomena are "innovating" upon the paradigms of key natural forces. Putting the question of the evolution of forces aside and to speak of the development of knowledge alone, the inquirer's relationship to tradition, in Novalis's view, is not put down to a sheer linear cumulative collection of scientific facts. It is well known that Thomas Kuhn has shown how advances in the sciences often involved the tidying up of innovative approaches and findings so as to make them appear that they fitted into a perfect linear progression of scientific knowledge.[20] Novalis's remarks about tradition arguably go further: behind the progression of the sciences lies a certain method and inner logic. In his notion of representation Novalis looks beyond formal theory to the origins of theory itself and the way ideas are formed. In his notion of "Plastisirung" lies an answer to the way knowledge is gained: it is an answer that leads away from theory alone to the proposition that there is a relationship between objects, language, and our ideas. Novalis's notion of representation promotes their relationship by proposing that types, models and analogies are key factors in scientific discovery. Tore Nordenstam has underlined how this approach to thought has often been traditionally neglected:

There are things which are so close to us that it is difficult for us to see them, like our languages and our bodies. The discovery of the central roles of our language and bodies in human existence is late one. It belongs to our own century (*250*, 64-65).

Its acceptance most probably belongs to this century, but as, for example, the thoughts of the Romantics - such as Novalis - show, it is an age old preoccupation. Further, coming back to the modern context, Ziman, in his concept of reliable knowledge, argues for the key role of analogy within scientific communities. The way scientists arrive at consensus is through "analogous personal experiences and a language in which something can be said about inner consciousness" (*302*, 189); within the area of reliable scientific thought itself "we can scarcely avoid the conclusion that most of our thinking is analogical and metaphorical" (*302*, 25). Referred to earlier were also the works of Hesse (*196*), Rudwick (*268*) and Gooding (*176*) for their interests in models and visual language, which are factors directly linked to the notions of metaphor and analogy. Novalis's idea of representation indeed concurs with these types of concerns in modern philosophy and history of science.

Novalis fits his notion of representation out with a method, as will now be shown. He sees inquiry having to move outwards from evident principles and phenomena (*N*, 3, 603). In doing so, Novalis proposes the use of an "experimental calculus" ("Experimentencalcul") operating with representative symbols and notions (*N*, 3, 435). Through the employment of significant symbols in an increasing series of experiments progression in inquiry is attained. Novalis comments:

Ansicht eines Experiments in einer steigenden Reihe von Gesichtspuncten (*N*, 3, 91).

To use the example of phosphorus again, it can be said that Novalis sees phosphorus as the "common denominator" of much of the pneumatic debate. Novalis implies that this debate can be summarized as a series of experiments and an ideal calculus based upon the substance phosphorus. Further, in Novalis's view, phosphorus attained the status of a natural philosophical principle or symbol, not only through its widespread use, but also, concomitant to its use, because it was a potent symbolic concept. As a symbol phosphorus contained within itself the seeds of a variety of theoretical stand points concerning matter theory. These included, amongst others, notions of chemical affinity, deflagration, vitalism - notions which were precursors to an idea of energy -, and even ideas of planetary motion.[21] Novalis attributes the same sort of symbolic potence to the nerve in galvanic theory. Here, the use of the nerve, in Novalis's view, opens up the study of the unity of inorganic and organic forces. He saw that the concept of the nerve in Ritter's work on galvanism made it possible to discuss notions of circuits, forces, chemical affinity, excitability and organization all at one fell swoop. Around the symbolic notion of the nerve a calculus of discovery is erected, and it is the nerve which guides the process of discovery. It is particularly in the diagrams that Ritter made of his galvanic experiments that Novalis finds most explicit expression of an ideal calculus in operation, because it is in the diagrams that the real formulas ("reale ... Formeln") of the ideal calculus are most visible. Novalis views Ritter's diagrams as a type of symbolic language that mediates between his galvanic theory and the phenomena investigated in the experiments.

The link between Novalis's "experimental calculus" and mathematical calculus lies in the way symbols are employed as constants within an "experiential" formula. To Novalis, the fundamental method of mathematical calculus is expressed in the way relationships between objects are used to attain further results. In Novalis's ideal calculus, symbols of significant phenomena are combined with and related to other phenomena under observation in empirical work. Out of the synthesis of their combinations and relationships new knowledge is gained. Novalis had read Condorcet's (1743-1794) work, *Entwurf eines historischen Gemähldes der Fortschritte des menschlichen Geistes* (*20*), where hopes are raised for the possible extension of the method of mathematical calculus to other areas of knowledge. Novalis comments on this work:

Nach Condorcet lehrt der Inf[initesimal Calcül ... eine Methode, die, da sie sich auf alle Combinationen veränderlicher Gr[ößen] und auf alle Hypothesen ihrer Veränderungen erstreckt, auf gleiche Weise für alle Dinge, deren Veränderungen eines bestimmten Maaßes fähig sind, entw[eder] die Verhältnisse ihrer Elemente, aus der Kenntniß der Verh[ältnisse], welche die Sachen gegen einander haben, oder die Verhältn[isse] der Sachen, wenn nur die ihrer Elemente bekannt sind, bestimmen lehrt (*N*, 3, 425; *20*, 234-235).

To Novalis this meant that by studying the affinities of things for another ("Bestimmungsverwandtschaftslehre"), and by using their combinations, discovery could take place (*N*, 3, 424). To some extent, this was a mathematization and extension of eighteenth century affinity theory. In other words, by studying the relationships of known objects, further knowledge about the objects can be obtained.

Condorcet remains vague about actual examples of the extension of the method of calculus to other areas of knowledge. Novalis, however, gives several examples of how he believes it can be used in an extended sense, as in the cases already given of phosphorus and the nerve; a further case is given below in the context of Werner's mineralogy. Novalis's source for an ideal calculus lies, however, not in Condorcet, but elsewhere in the philosophical style of Plotinos, in Hemsterhuis, and also in the work of Werner. In fact numerous sources play a role in shaping Novalis's notion of an ideal calculus. One can, for example, further cite, first, the thoughts contained in Leibnitz's (1646-1716) *Theodicee* and "Combinatorik" (*70*), and then, the scientific method of Goethe and of Ritter. Hemsterhuis's notion of the "sympathy" between man's ideas and phenomena, and the adjunctive proposition that man has an innate knowledge of the combinations of phenomena, form an important starting point for Novalis's concept of "Combinatorik" or ideal calculus. It could even be argued that Novalis's whole view of knowledge can be put down to his notion of an ideal calculus and representation. To "romanticize" means making a natural philosophical science of knowledge, including literature, too (*N*, 3, 256, 280-281). The skill of romanticizing, which Novalis believes is an as of yet unknown art ("Diese Operation ist noch ganz unbekannt" (*N*, 2, 545), lies in drawing relationships between the finite and infinite, the everyday and the transcendent. Through representation a relationship is formed between otherwise disparate things:

> Die Welt muß romantisirt werden ... Indem ich dem gemeinen einen hohen Sinn ... gebe so romantisire ich es - Umgekehrt ist die Operation für das Höhere, Unbekannte, Mystische, Unendliche - dies wird durch diese Verknüpfung logarythmisirt - Es bekommt einen geläufigen Ausdruck. romantische Philosophie. Lingua romana (*N*, 2, 545).

This well-known remark shows how Novalis interprets the method of mathematical calculus and the way he views it in terms of his wider notion of an ideal calculus.

Fundamentally, Novalis views mathematical calculus as an activity which draws relationships between things in order to gain knowledge. In Novalis's literary works not only is scientific material used as a source, but also the same "plasticizing" method used in the sciences is employed to "construct" the texts. As in his notion of scientific method, in literature sequences of significant symbols are used: the difference being that in literature the symbolic calculus is used to propose a vision of the human state, and in the sciences the calculus of the discovery process is used to attain a theory about natural phenomena. In the final instance, however, both literature and science, by virtue of their common natural philosophical stance, are attempting to put forward a view of man's position in Nature.

Schelling does not explicitly propose the use of an ideal calculus for inquiry, but he does comment on the relationship between the method of mathematical calculus and his method of natural philosophy. When speaking of the task of all science Schelling remarks:

Möglichkeit der Darstellung des Unendlichen im Endlichen - ist höchtes Problem aller Wissenschaften (*108*, 14).

The natural philosopher is concerned with formulating the great infinite series of Nature, but unlike mathematical calculus which operates using combinations ("Zusammensetzung"), the infinite series of Nature arises through "Evolution". Schelling states that the infinite "evolutionary" series can be viewed as operating according to a "function". Importantly, the key factor within the "function" must be a concept of "activity" ("der Begriff einer Thätigkeit"). Schelling says of the issues surrounding the adequate expression of the infinite series of Nature:

Wie muß man sich nun aber eine unendliche Reihe vorstellen, wenn sie nur die äußere Darstellung einer ursprünglichen Unendlichkeit ist? Muß man glauben, daß das Unendliche in ihr durch Zusammensetzung erzeugt werde, oder vielmehr muß man sich jede solche Reihe in Continuität, als Eine ins Unendliche fließende Funktion vorstellen? - Daß in der Mathematik unendliche Reihen aus Größen zusammengesetzt werden, beweist nichts für jene Annahme. Die ursprünglich unendliche Reihe, wovon alle einzelnen (in der Mathematik) nur Nachahmungen sind, entsteht nicht durch Zusammensetzung, sondern durch Evolution, durch Evolution Einer in ihrem Anfangspunkte schon unendlichen Größe, die durch die ganze Reihe hindurchfließt ... Der eigentliche Begriff also für eine empirische Unendlichkeit ist der Begriff einer Thätigkeit, die ins Unendliche fort gehemmt ist ... (*108*, 15-16).

Schelling's natural philosophy strives to find the key forces and phenomena which occur and develop along the infinite series of Nature. The series is referred to by Schelling as "Epochen", and, also, importantly for the present discussion, as "Reihen" (*221*, 115-117, 125). The notion of a "series" or "row" of objects in experimentation is part of Novalis's concept of a calculus. The notion of "rows" forms also part of Werner's thought as is discussed below in his mineralogical method. The type of concepts ("concepts of activity") required by Schelling for the establishment of a series of Nature are clearly related at ontological and epistemological levels with Novalis's notion of "wircksame Begriffe". However, it should be noted that Schelling's views here are concerned with establishing a philosophy of nature, and are not directly related to Novalis's concern with a method for scientific discovery itself. At another level one can say that Schelling's natural philosophy is concerned with the discovery of Nature itself, but the distinction made between Schelling and Novalis is just. In his notion of method Novalis refers not only to the discovery of Nature's first principles but also to discovery processes in the laboratory, as his views on the use of phosphorus and on Ritter's work on galvanism show.

Schelling's use of what he calls "Zwischenglieder" or "Mittelglieder" (mid-terms) is, however, more comparable to Novalis's concern with scientific discovery. The "Zwischenglieder" are terms, taken from the empirical sciences, that mediate between the activities of the strictly empirical inquirer and the principles of the "Naturphilosoph". An example of Schelling's use of "Zwischenglieder" has been shown by Poser. Poser comments how Schelling, in his *Allgemeine Deduktion*, refers to a line ABC in the first instance in a formal geometric fashion (*258*, 134; *111*, 8-9). Schelling then goes on to use the line ABC to illustrate the properties of a magnet:

Aber diese drei Punkte sind diejenigen, welche zu der Construktion des Magnets nothwendig sind. Denn in jedem Magnet findet sich a) ein Punkt, in welchem nur die positive Kraft ihre Wirkung äußert ... b) Ein Punkt, wo der Magnetismus weder + noch -, wo also eine völlige Indifferenz ist. Dieser Punkt ist der gemeinschaftliche Grenzpunkt beider Kräfte und entspricht dem oben abgeleiteten Punkt C. ... Da ich den Magnet als reine Linie betrachte, so kann ich auch nur von einem indifferenten Punkt sprechen; am wirklichen Magnet nennt man die ganze gleichgültige Stelle den Aequator des Magnets. c) Einen Punkt, wo nur die negative Kraft herrschend ist, welche von dem Gleichgewichtspunkt an allmählich zunehmend endlich in jenem ihr Maximum erreicht (*111*, 9-10).

When the line ABC is linked to the phenomenon of the magnet, unlike the example of the geometrical line, the line becomes a representation of a phenomenon. In this instance Schelling is directly theorizing with phenomena. In his scheme of a magnet Schelling shows how theory can be given a definite form, and vice versa, how phenomena can be represented as theory. This enables the inquirer to gain a concrete idea of the theoretical issues at hand. Schelling's use of the term "Zwischenglieder" does, then, concord with Novalis's view of representation in inquiry and its use in expressing key empirical concepts. Like Novalis, Schelling is close here to the scenes of discovery. The difference between the two thinkers is minimal and lies in Novalis's extension of representation to the abstracter and more mathematical sounding notion of an ideal calculus.

Moreover, in his use of the term "Zwischenglieder", Schelling appears to erect a greater barrier between his natural philosophical activities and those of the strict empirical scientist of his time than there actually was. In his *Einleitung zu dem Entwurf eines Systems der Naturphilosophie* Schelling states that it is the task of empirical science to find the "Zwischenglieder" and that it is the task of his natural philosophy to ascertain their lack:

Diese Zwischenglieder aufzufinden, ist das Werk der experimentirenden Nachforschung. Die spekulative Physik hat nichts zu thun als den Mangel dieser Zwischenglieder aufzuzeigen (*109*, 279).

Surely, one can argue, given the definition of principles and "Zwischenglieder" in his natural philosophy, are they not anyway of empirical value? Schelling's point is however to establish a difference between "blind empiricism" and a more critical form of scientific inquiry. Seen in the greater context of practical knowledge and the issues surrounding the formation of knowledge, the apparent conflict between the *a priori* and *a posteriori* in Schelling's work is not a methodological problem as one critic, Poser, thinks (*258*, 134-136). Part of the problem of Poser's approach, and also of Heckmann's,[22] is that they take terms such as "empiricism" and "experiment" at face value, without stressing analogous forms of experiential thought in other parts of Schelling's philosophy. Schelling's notion of human thought has many experiential aspects, just as his notion of natural philosophy can be seen as a higher form of empiricism. Schelling is not concerned with formal knowledge, instead he seeks to unite the practical and the theoretical, and his philosophy offers a strong fundament for beginning upon this task. His natural philosophical activities are necessarily linked to and bound up with the activities of the empirical scientist. The difference between Schelling's principles and "Zwischenglieder" would need to be discussed in detail in a separate study, and its resolution would probably lie firstly in the difference in value between his principles and "Zwischenglieder" when viewed in light of the sciences of his time. Secondly, the answer would probably be seen in the development and change of key "Zwischenglieder" into higher level principles within his natural philosophy. The main point to make here, however, is that Schelling's principles and "Zwischenglieder" and Novalis's "wircksame Begriffe" are particular notions based upon material from the empirical sciences which are in turn given a significant position within their natural philosophical approach to inquiry. Important to note, too, is that, although Schelling's "Zwischenglieder" are not as directly related to discovery processes as Novalis's notions of discovery, the way Schelling works with them is intended to give guidance in inquiry. In this sense, Schelling's "Zwischenglieder" are methodologically of equal importance to discovery as Novalis's notions of "wircksame Begriffe", notation, symbols and "Plastisirung". Both Novalis and Schelling wish to select and show the relevance of key empirical terms for inquiry; they wish also to show how the terms can be put to use to assist the inquirer. The empirical scientist can be helped when empirical terms are placed within a greater natural philosophical context. The empirical scientist can further be assisted, in their view, when methods are suggested for working with and refining the terms, be it through Schelling's forms of reasoning and the style in which he describes phenomena (e.g. in the example of the magnet) or through Novalis's use of an ideal calculus and notation.

Schelling's notion of "Zwischenglieder" raises important questions about the role of aesthetics in his natural philosophy. In his *System des transcendentalen Idealismus* Schelling proposes significant links between aesthetics and philosophy. In fact, aesthetics is the culmination of philosophy. It is art which provides the final objective step in the progress of the "Anschauung" in Schelling's transcendental philosophy towards higher levels of knowledge; Schelling states that his transcendental philosophy coheres as a whole when seen as such a progression:

Daß ferner der ganze Zusammenhang der Transcendental-Philosophie nur auf einem fortwährenden Potenziren der Selbstanschauung beruhe, von der ersten, einfachsten im Selbstbewußtsein, bis zur höchsten, der ästhetischen (*110*, 631).

Aesthetic production thus goes through the same stages as philosophical production. The aesthetic intuition resolves philosophy's problem of conceiving the absolute by realizing the absolute in a finite work of art (*110*, 624-5). In its attempt to conceive the absolute, philosophy works at synthesizing the infinitely opposed activities of the spirit and nature (such as attraction and repulsion, subject and object) into ever higher forms of knowledge. Philosophy partially resolves the infinite dichotomy of opposed activities ("die unendliche Entzweiung entgegengesetzter Thätigkeiten") by referring to ever higher forms of knowledge (and natural forces), culminating in the "produktive Anschauung"; art, on the other hand completely ("vollständig") (*110*, 626) resolves this antithesis in a product:

Jenes produktive Vermögen ist dasselbe, durch welches auch der Kunst das Unmögliche gelingt, nämlich einen unendlichen Gegensatz in einem Produkt aufzuheben" (*110*, 626).

This cannot, however, be seen as Schelling's final view on the natures of art and philosophy. It would appear that the concrete nature of Schelling's "Zwischenglieder" can arguably be seen as a type of lower level aesthetic intuition. They are certainly different from Schelling's Kantian sounding notion of a "Schema" which he attributes to philosophical knowledge. Schelling remarks that what the "Schema" is to the philosopher, the "Symbol" is to the artist. Here, Schelling differentiates between the way the artist in dealing with ideas employs symbols as a form of communication and the way that the philosopher uses "Schema" to transmit his concepts (*110*, 510). Schelling's employment of an "ideal" magnet has, however, more to its epistemological status than a concept. At the level of knowledge formation it can be interpreted as scientific art: the ideal magnet is a product of the imagination, and it is thus a product akin to those produced by Schelling's aesthetic intuition. In his System Schelling remarks that both philosophy and art use the imagination, but that it is only art that provides a product (*110*, 626): crucially it is a natural philosophical "Zwischenglied" such as

Schelling's magnet that both employs the imagination and is a product of the imagination.

There are, moreover, further ramifications to Schelling's notion of "Zwischenglieder" in the context of his views on aesthetics in his *System des transcendental Idealismus*. It is the objectivity of art that leads Schelling to the notion that the "Gedicht" of Nature remains hidden "in geheimer wunderbarer Schrift" (*110*, 628). Schelling desires to bring science back to its original point of genesis, that of poetry ("Poesie"), and he suggests the appropriate "Mittelglied" for such a task is mythology (*110*, 629). This task he undertakes in his later philosophy and the sense of the task lies not in the study of individual artists, but in the study of races (*110*, 629). The study of races in terms of mythology clearly dovetails neatly into Schelling's quest for a study of the human spirit and its links to the spirit of Nature. None the less, Schelling, at this point in his work, leaves many questions surrounding natural philosophy open. Mythology is a "Zwischenglied" at the highest level of theory: however, lower level "Zwischenglieder" such as his ideal magnet, with their aesthetic connotations, are of great interest for defining his notion of natural philosophy itself before steering on to his notion of mythology. Such lower level "Zwischenglieder" also bring Schelling closer to the works of other early Romantics. For the relationship between the arts and the sciences such lower level "Zwischenglieder", if seen as types of natural philosophical principles, and if viewed in the way they link artistic and scientific modes of production, are valuable for gaining insights into how scientific ideas are not merely reflected in texts. This interpretation of his "Zwischenglieder" moreover also bears upon his higher level natural philosophical principles themselves. Schelling refers to philosophical knowledge as "künstlich" and to art as original and natural ("ursprüngliche und natürliche") (*110*, 628), but is this entirely fair to his own natural philosophy? One can argue that his natural philosophy, like art, does provide products, and natural and original ones at that. There is little difference arguably between a natural philosophical principle of Schelling's such as polarity and Goethe's "Urpflanze". The former refers to a force and the latter to an object, but both are dynamic, generative models. Viewed in this manner, there is a certain aesthetic quality to Schelling's natural philosophical principles. Schelling is not literally an artist, but he is certainly a philosophical artist.[23] Schelling would appear to allude to this when he remarks:

Nemht, kann man sagen, der Kunst die Objektivität, so hört sie auf zu seyn, was sie ist, und wird Philosophie; gebt der Philosophie die Objektivität, so hört sie auf Philosophie zu seyn, und wird Kunst (*110*, 630).

To conclude, if lower level "Zwischenglieder" and key natural philosophical phenomena and forces are viewed in this light, they also provide links between the arts and the sciences in terms of knowledge formation, and, further, in terms of purposive processes in nature in which the human spirit is bound. Such is the case, for example, regarding the manner in which Novalis treats Ritter's notions of galvanism in the "Märchen" in *Heinrich von Ofterdingen*, or regarding the way Goethe treats affinity in *Die Wahlverwandtschaften*.

Finally, moving away from the role of aesthetics to issues of scientific inquiry itself, a further observation on the purpose of Novalis's and Schelling's natural philosophy must be made. Novalis and Schelling were both aware of the enormity of the exercise of singling out particular notions and phenomena. For both of them natural philosophy was an ongoing task and the real importance of their activities lay in finding the correct method with which the task could be carried out, and in setting an agenda at all for natural philosophical inquiry. Schelling argues that the empirical sciences need natural philosophy because of the danger of the hypothetical holding up progression in inquiry. When science adheres too resolutely to a particular theory, natural philosophy should be called upon to reassess the situation in its fuller context and reset the agenda of inquiry:

[...] da aber jede neue Entdeckung uns in eine neue Unwissenheit zurückwirft, und indem der eine Knoten sich löst, ein neuer sich schürzt, so ist begreiflich, daß die vollständige Entdeckung aller Zwischenglieder im Zusammenhang der Natur, daß also auch unsere Wissenschaft selbst eine unendliche Aufgabe ist. - Nichts hat aber den ins Unendliche gehenden Progressus dieser Wissenschaft mehr aufgehalten, als die Willkür in Erdichtungen, womit so lange der Mangel an gegründeter Einsicht verborgen werden sollte. Dieses Fragmentarische unsrer Kenntnisse leuchtet erst dann ein, wenn man das bloß Hypothetische vom reinen Ertrag der Wissenschaft absondert, und darauf ausgeht, jene Bruchstücke des großen Ganzen der Natur wieder in einem System zu sammlen. Es ist daher begreiflich, daß *speculative* Physik (die Seele des wahren Experiments) von jeher die Mutter aller großen Entdeckungen in der Natur gewesen ist (*109*, 279-280).

It is the scope of Novalis's and Schelling's natural philosophy (i.e. their agenda) and their method (i.e. their views on experiential knowledge) that avert the dangers of hypothesis in inquiry.

The philosophical empiricism of Novalis and Schelling is not unique. Goethe, too, gave much attention to the topic. However, before discussing Goethe's views, let us turn our attention to a pre-Romantic thinker who had a great influence on the Romantics: the geologist Werner. The far reaching significance of Werner for geology has often been neglected (*231*, 112). The importance of Werner's geology for a general theory of rock formation, reaching beyond the antipathies of the Neptunist and Vulcanist camps, has been illustrated by Rachel Laudan (*231*, 87-200). Werner's role in the development of geology in terms of chemistry and geological method has also been emphasized recently (*172*). I wish now, tentatively, to reassess another aspect of Werner's approach to the sciences: that of his notions of practice. Werner's influence on Novalis cannot be disputed: Novalis studied under Werner at the mining academy in Freiberg and was himself a practicing inspector of mines. Novalis came to Freiberg after his studies of Kant and Fichte and was greatly effected by the "empirical" world he found there. After some initial concern over the plainness of his scientific and technological studies, Novalis's world view underwent major changes: it was at Freiberg that Novalis began to form a philosophy that was to unite contemporary science, Neoplatonism, and German Idealism. Within the area of practice Werner's influence on Novalis will now be traced; Novalis's views on Werner's mineralogical and geognostical theories are not dealt with here since that is worthy of a study in itself. Such a work would undoubtedly need to treat Werner's notions of classification and encyclopaedism and relate them to Novalis's classification project in *Das allgemeine Brouillon*. Furthermore, a full account of Novalis's and Werner's views on chemistry would need to be delineated so as to see how the progression of chemical ideal types to geognostical ideal types form part of greater picture of their natural philosophy. Werner's chemistry has been dealt with by Fritscher (*172*), but his notions of encyclopaedism are still an uncharted area. An in-depth study of Werner's relationship to Novalis is still outstanding. It will further be suggested that Werner affected Humboldt's views on practice. Extrapolations will also be made from Fritscher's recent article on Steffen's employment of Werner's geological theory to show links between practice and Werner's notion of geological ideal types. Furthermore, for the history of science itself, it must be noted that the potential multiplication effect of Werner's views, given the large array of influential and international students he taught, makes him a figure worthy of study.

With Werner it is tempting to speak of time and history alone when discussing his views of the sciences and knowledge: geology, seen as the history of the earth, naturally lends itself to this interpretation. Method, however, is also a crucial element of Werner's thought. Importantly, key methodological issues are raised in an area of Werner's work which is not concerned directly with history, namely his mineralogy. In his geognosy, history clearly plays a role, but equally so does his view on method. In his mineralogy Werner classifies the minerals and rocks by ordering them in rows ("Reihen") or suites ("Suiten") according to particular experiential principles. The suites show the gradual changes and the relationships between the minerals and rocks. In the mineral collection of Pabst von Ohain (1718-1784), for example, Werner ordered the minerals in suites according to various viewpoints such as "Bruch, Durchsichtigkeit, äußerer Gestalt" etc.[24] Of significance for Romantic method are Werner's notions of "Reihung" and "Mischung", for with these terms Werner demands that the inquirer should directly theorize with the phenomena under investigation. "Reihung" involves the task of observing the transitions ("Übergänge" and "Aneinanderstoßen") between minerals; the notion of "Mischung" demands that the inquirer should observe the effect the chemical composition of minerals has on their external appearance (*181*, 51-54). This ordering of rocks according to empirical principles undoubtedly influenced Novalis. Werner's terms of classification are notions that are evident and sensually based, and the way Werner employs them is highly akin to Novalis's later method of sensual representation in his notion of "Plastisirung". Novalis praises Werner for his strict adherence to the experiential, for it is in the emphasis on experiential, as opposed to formal knowledge, that Novalis views the possibility of ordering phenomena at all:

Wenn Werner zuförderst auf vollst[ändige] und gutgeordnete Fossilbeschreibungen dringt, so hat er sehr recht.
Die Beschreibung ist die Beobachtung des Fossils. Vollständigkeit und richtige Ordnung sind die wesentlichen Best[and]th[eile] einer Beobachtung ... Die Ordnung hängt von der Beschreibung ab. - Sie ist das Resultat d[er] Beschr[eibung]. Ordnung ohne Beschr[eibung] ist Behauptung, ohne Beweis (*N*, 3, 142).

An experiential approach to investigating phenomena that employs sensual representation gives rise to theory itself. Such an approach provides a natural history that orders phenomena in a way that does not lose sight of their character, letting them guide inquiry themselves: in this manner phenomena are ordered as closely as possible according to Nature and not according to formal theory. Such an approach also upholds the need for the inquirer to develop a feel and sense for Nature through description and the direct theorizing with phenomena involved in experiential thought: attaining a sense for nature is the primary prerequisite of the ability to order phenomena. When Novalis emphasizes description he is not arguing for plain induction; it is precisely the description of phenomena that allows mediation between theory and phenomenon, and, further, allows the inquirer to build up his practical knowledge. This in turn provides the base for further inquiry and the formulation of theory.

Werner also, in accordance with Novalis's idea of testing theory (i.e. testing the way we perceive phenomena), experimented with different forms of ordering the rows of minerals. Here, in a highly concrete manner, the meaning behind Novalis's notion of "experiment" in the testing of experiential knowledge can be understood. Different theoretical viewpoints are physically shown in the various forms in which the minerals are ordered.

Furthermore, in an illuminating comment on Werner's mineralogical work, *Von den aüßerlichen Kennzeichen der Foßilien* (*124*), Novalis extrapolates from Werner's method and links it up to his own notion of an ideal calculus. Novalis refers to Werner's use of colour terminology and suggests that the mineralogist should be equipped with the significant mineral colours and the general rules of mineralogical classification. Using these principles in a symbolic calculus, the inquirer should be able to come to his own conclusions about classifying rocks and minerals. The Wernerian experiential terms form the base of a mineralogical discovery process:

Der Oryktognost braucht nur die Hauptfarben hinzustellen - und die allg[emeine] Regel zu geben, daß der Schüler suchen soll recht viele concrete Farben ins Gedächtniß zu fassen. Dadurch wird er vorbereitet - zu der Kunst - Farben im Kopfe zu zerlegen und zu mischen ... Diese Kunst gehört in die Bildungslehre der Fantasie ... Der eigentliche mineralische Chymist ... lehrt den mineralischen chem[ischen] Calcül (*N*, 3, 151-152).

Finally, reference to tacit knowledge has to be made with respect to Werner. It is well known that he had an extraordinary sense for the materials that he worked with (*348*, 23, 53-55). The fact that Werner "knew" where to place a stone in a classification system by having a "sense" or "feel" for the stones themselves is intimately linked to the experiential principles of his system. It can be said that this type of tacit knowledge of the stones and minerals is a prerequisite for the creation of his classification system.

The above portrayal of practical and tacit knowledge has argued that the path from experience to theory involves mediation. The implication is that experiential knowledge always plays a role in knowledge formation, and that selectivity and interplay between the inquirer and the phenomena are key factors at this stage of inquiry where definitions are made that lead to a final formulated theory. Although Hofbauer, in a recent article, has argued forcefully for the picture of Werner as an Enlightenment sensualist empiricist concerned, above all, with the description of nature, this view does not give enough credence to the selective nature of Werner's method and the fact that it contained powerful tools for the formation of knowledge (*198*, 549-551). Naturally, the discussion about Werner's method is not greatly helped by merely stating that Werner had an indefinable tacit sense for the materials he worked with. The notions of tacit and practical knowledge do more than that, however, since they imply a certain capacity for selectivity on the part of the inquirer, and, also, the related ability to theorize with phenomena using experiential open-ended terms. Not only Werner's mineralogical classification system and his notions of geognosy, but also his entire teaching programme can be seen as being formed to institutionalize important constitutive rules for geological practice (not regulative rules). Setting open-ended rules for geological practice forms, in turn, the basis for the future of geological theory itself. The immense importance of Werner's mineralogical system and his institutionalization of petrographic mapping are but two examples of his achievements in this area of knowledge.[25] Furthermore, even if Werner had no explicit geognostical theory (*198*, 554), his views certainly embraced concepts which travel towards a notion of natural history ("Naturgeschichte") - a theme which will be returned to below.

Goethe was a great admirer of Werner and a supporter of his Neptunist theory. Whether Goethe's notion of practice was affected by Werner is not the subject of analysis here. The main issue is to stress similarities in approach between early Romantic thinkers, including Goethe in this category, with the necessary reservations. Later, it will be shown, for example, that Humboldt's turn to Vulcanism does not negate the influence of the Neptunist Werner, since the aim of this study is to steer beyond doctrines to a deeper level of consensus in the early Romantics by examining their notions of practice, and, as will be further elaborated, their use of ideal types.

Goethe's views are of great interest to Romantic science since his life's work on the sciences is an embodiment of what came to be Romantic practice. A series of recent works, to varying extents, have treated Goethe's methodological interests. In 1984, Böhler, in his essay, 'Naturwissenschaft und Dichtung bei Goethe', has drawn comparisons between Goethe's notions of aesthetic or philosophical productivity and his notions of scientific productivity. Böhler remarks:

> Was tut die eine - die dichterische Tätigkeit -, was die andere - die wissenschaftliche Forschung - nicht tut? ... Die Stufenfolge ist ... "Ansehen" - "Betrachten" - "Sinnen" - "Verknüpfen", eine Reihung, die den Prozeß der wissenschftlichen Beobachtung bis zum Punkt der Theoriebildung umschreibt und die uns ziemlich unproblematisch und wohl auch unumstritten scheint. Diese Reihung ist nun aber mit einer weitern Stufenfolge verknüpft: "Bewußtsein" - "Selbsterkenntnis" - "Freiheit" - "Ironie". Diese zweite Stufenfolge könnten wir als einen Prozeß des reflektierenden Selbstbezugs bezeichnen. Ist der erste Prozeß, der der Theoriebildung, ein Prozeß der Welterfassung und damit nach außen gerichtet, so der zweite ein solcher der Subjekterfassung und somit nach innen gerichtet (*143*, 328-329).

The notion of a row, as has been and will be further discussed, is a key pattern in early Romantic thought. Further, quite specific alignments of aesthetic and scientific productivity with one another will be seen below in Goethe's notion of experiment in the light of Goethe's views in his essay, *Der Versuch als Vermittler von Objekt und Subjekt* (*41*).

In 1987, in the illuminating collection of essays edited by Amrine, Zucker and Wheeler, *Goethe and the sciences: a reappraisal* (*132*), there are many critics who deal with Goethe's methodology. Böhme, for example, refers to the "intersubjectivity" of Goethe's scientific method (*144*, 164-169). Böhme points out how Goethe meaningfully upholds his distinction between objective and subjective colours. Böhme argues that Goethe, "by giving the conditions of the experiment", assures "intersubjectivity" for both types of colours, and, thus, provides the grounds so that both types of colour phenomena can be reproduced (*144*, 167). Hegge, among others, takes the notion of experiment a step further and argues that Goethe's understanding of experiment takes a stand against hypothetico-deductivism and notions of the testing of theory. Instead, the experiment's main feature lies in its use for training the sensory imagination (*190*, 212). This, I would add, is important for understanding the experiential-cognitive approach to "experiment" that links Goethe and Novalis. Zajonk makes use of Polanyi's notion of tacit knowledge to explain what lies behind Goethe's idea of the archetype (*301*, 241; *256*, 144). To Zajonk, Goethe's science is concerned with perception and scientific discovery, and this cognitive orientation in Goethe's thoughts on the sciences, as Zajonk further remarks, "is what Polanyi would call a perceived coherence. Goethe would perhaps go further and call it the universal in the particular, the ideal in the real" (*301*, 241). Furthermore, Zajonk briefly intimates that he would like to view Novalis as akin to Goethe in this respect. He sees in Novalis's idea of man's inner organ a form of knowing that acquires its wisdom about nature through a close association with phenomena, and not through hypothesis (*301*, 241-242).

Another critic, as will be discussed below in detail, Sepper, in his work of 1988, *Goethe contra Newton. Polemics and the project for a new science of color* (*276*), has most effectively examined Goethe's view of scientific method.
Another significant work is Adler's, published in 1987, namely *"Eine fast magische Anziehungskraft". Goethes "Wahlverwandtschaften" und die Chemie seiner Zeit* (*129*). This shows the unity of aesthetics and science in the above novel of Goethe's. In the realm of its study, chemistry, and in the great detail of the multiple levels of interpenetration of aesthetic and scientific thought, Adler's work arguably underlines more clearly the blend of science and aesthetics in Goethe's notion of knowledge than the essays of the collection referred to above. Adler shows how a whole string of interdependent factors - within the realms of natural philosophy, scientific thought and literature - move in and out of their various areas of knowledge. In the depth of its portrayal of the interpenetration of a variety of factors in Goethe's thought, Adler's work is a major step forward in Goethe

scholarship, and also, consequently, offers a new understanding of early Romantic thought. Adler's work can thus be read highly profitably in terms of natural philosophical productivity since, as mentioned, its distinction lies in the way it portrays a variety of levels of practical, aesthetic, and intellectual interpenetration. Adler remarks:

> Betrachtet man ... die gesamte Darstellung der "Wahlverwandtschaft" ... als Ausdruck einer "Idee", so erweist sie sich als ungemein reich gegleidert: sie erstreckt sich von einer Morphologie der Beziehungen zu einer Erkenntnistheorie; von einer Typologie chemischer Verhältnisse zu einer Serie von Parallelen im menschlichen Leben. Die "Verwandtschaft" bildet den Kern der "Idee"; die "Wahlverwandtschaft" ist ihre höchste Entfaltung. Symbolisch steht diese auch für den ganzen Komplex. Einmal äußert sich die "Idee" im Menschen, einmal in der Chemie. So liefert die "Idee" das "Model" oder "Urbild" der Beziehungen und Verhältnisse im Roman. (*129*, 140).

Adler's interpretation of Goethe's notion of "Idee" in terms of experiential knowledge, and in terms of its recourse to Plotinos, has already been discussed (see above, p.51). It is clear that the "Idee", in Goethe's view, is both a tool of knowledge formation for the sciences and also for literature. In both cases concrete, symbolic and constitutive knowledge formation takes place. The fact, too, that the notion of "Wahlverwandtschaft" is the key symbol of the entire "Komplex" of Goethe's thought which Adler deals with readily recalls Novalis's idea of a "phenomenal" calculus: for there ideas and phenomena are drawn together and compared in a process of interpenetrative concrete knowledge formation. This view of Goethe's thought comes exceedingly close to Novalis's idea of knowledge, and their proximity will be discussed at various stages in this work.

However, Goethe scholarship, until recently, has, in general, not treated Goethe in terms of the issues of practice as understood in this dissertation. This was because of the prevailing picture of Goethe as the non-philosopher. This has partly come into being because of Goethe's hesitant stance towards Kant, and also because he sometimes dismissed German Idealism and the Romantics. Goethe had, of course, read Kant and tookcognizanceɔf his ideas - but his final stance towards Kant is probably ironical, as was Novalis's, too. An instance of Goethe's distancing from German Idealism - in the form of Schelling - takes place, for example, in 1802, but up until then Goethe held Schelling in great esteem.[26]

Importantly, Kleinschnieder has shown the seriousness of Goethe's project in Kantian terms (*213*). Kleinschieder's analysis provided a much needed defence of Goethe's views on the sciences at a time when they met more general hostility. None the less, to understand Goethe as a philosopher, one has, arguably, to search beyond Kant. Sepper's work on Goethe, although highly illuminating on Goethe's colour theory and his relation to Newton (1642-1727), says little about the broader contemporary context of Goethe's methodology: there is virtually no reference to German Idealism. Goethe's scientific methodology is, however, analyzed in great depth in its own terms. Sepper does bring Goethe's science into the modern context by showing how Goethe's concern for appearances and the phenomenal has a certain validity in fending off the dangers of modern science's tendency to abstraction. In this way Goethe's wish to keep the phenomena ever in sight has a genuine value in keeping research progammes aware of their origins and purpose (*276*, 188). However, although Sepper's views on Goethe's methodology do come exceedingly close to the concerns of this work, his conclusions do not create the overarching conceptual view of practice that this present work is seeking. It is correct, as Sepper does, to speak of the methodological variety Goethe was aiming at in his notion of "Vorstellungsarten" (a point already made by Kleinschnieder (*213*, 91-129)), and also of Goethe's view that science cannot be reduced to a single method, but instead to the whole experience of human beings. Valid as well are Sepper's remarks on Goethe's view that the aperçu anticipates the whole, i.e. the aim of a particular branch of inquiry, and the concomitant thought that science is thus related to art in the way it produces wholes which lead to ever more comprehensive wholes (*276*, 194). These comments are perhaps of too general value and tend to relativize the achievements of Goethe, although in other respects, such as Goethe's scientific method, Sepper shows the value of Goethe's thought. I wish to complement Sepper's work by adding further dimensions to Goethe's thought in terms of practical knowledge and early Romantic views of practice. I will return to Sepper below when speaking of Goethe's use of the term "Formel" and will draw comparisons with Novalis's methodology.

Other historians and critics such as Hildebrandt (*197*), Koch (*219*), Nisbet (*249*), Wolf von Engelhardt and Dorothea Kuhn (*169*) provide a wealth of information on the type of traditions Goethe was working within, but do not link the processes of inquiry with Goethe's own epistemology. These critics all work at defining

Goethe's notion of "Anschauung", "Symbol" etc., and then pass on to an interpretation of the "Urphänomen" or ideal type as related to such notions of thought.[27] Taking Nisbet as an example, it can be seen that where these works essentially draw their boundaries is at doctrinal explanations. It is, of course, upon the necessary base of such explanations that this present work seeks to forge on. Nisbet shows how Goethe merged the traditions of Neoplatonism and empiricism. The Neoplatonic notion of continuity in phenomena, as manifested in the Chain of Being, is thus seen to be linked to Goethe's notion "that the data furnished by experiments should be presented in continuous series" (*249*, 38). Nisbet further shows how Goethe's three stages of inquiry are linked to Bacon's. Where Bacon speaks of "senses and particulars", "middle axioms" and "general axioms", Goethe refers to "das empirische Phänomen", "das wissenschaftliche Phänomen" and "das reine Phänomen" (*249*, 27). Thus, "both thinkers believe that scientific generalization is a process of subsumption whereby the particular law is subordinated to the general until the comprehensive law, to which all individual cases are subject, is discovered" (*249*, 33-34). Importantly, as Nisbet points out, Goethe does not acquiesce with Bacon's notion of induction, since Goethe saw that any inquiry into nature always involves theorizing, as Goethe remarks: "so kann man sagen, daß wir schon bei jedem aufmerksamen Blick in die Welt theoretisieren" (*249*, 34; *40*, I, 4, 5). This is not to say that Goethe argues for hypothetico-deductivism; instead Goethe refers to the fact that we always come to phenomena from a certain theoretical viewpoint: phenomena cannot be purely inducted. Importantly, Goethe refers here also to his notion of experiential thought. Nisbet then goes on, in a similar manner to the other Goethe scholars mentioned, to discuss the link between experience and idea in Goethe's "doctrine" of the ideal type. Koch goes one significant step further by uniting Goethe's view of science and literature in terms of the symbolic, but again this is carried out in the manner of explaining a doctrine (*219*, 253-285).

Koch's views come close to the analysis of Goethe's methodology in this dissertation. Koch highlights how Goethe stresses the use of the "Anschauung" in the ordering ("Ordnen") of experimental results or observations. The ordering gives rise to a concept which is more than just a plain analytical statement, since it arises out of an intuition which synthesizes the series of phenomena. The resulting concept is, in fact, a mixture of the formal concept and the intuition, "der anschauende Begriff" (*219*, 59-60). What Koch does not do, as is also the case for

Wolf von Engelhardt, Kuhn and Nisbet, is to link the process of attaining intuitive concepts to the process of gradually ordering experiments and observations which lead to ever increasing clarifications of the finally attained intuitive concepts. This would require a study, neither of Goethe's finally attained theories nor of the doctrines he held, nor even of his scientific method alone, but, instead, of his scientific works in terms of aesthetics and science. The analysis would lead most probably, as the analysis of Ritter's work given later here, to the picture of layered steps in inquiry, based upon key symbolic phenomena, coming ever closer, in the tightening of a symbolic argument and demonstration, to the finally attained theory inherent in the notion of the "Urphänomen" (this can also be referred to as ideal type or "reines Phänomen"). Therein lies the key to the genre of Romantic philosophical method - that is the core structure repeated in Goethe's, Ritter's and Humboldt's work - and also, it can be argued, in Schelling's genetic method of natural philosophy.

The reason why this method of Goethe's has not been pointed out lies, as said, in the fact that critics and historians spring immediately to an explanation of the ideal type itself, or to explaining how Goethe could at all think in the way he does and pay so much heed to the intuition. It also perhaps lies in the fact that Goethe issues some highly rhetorical and apodictic comments about the differences between the scientist and the artist in a key work of his treating scientific method, *Der Versuch als Vermittler von Objekt und Subjekt* (*41*). There it is stated that the artist must entertain ("unterhalten") and thus leave his work open for further interpretation, whereas, in contrast, the scientist must spell out his intentions down to the very last detail (*41*, 13). But these thoughts of Goethe give the impression that the scientist only lays down formal, irreversible, objective knowledge - when in fact Goethe is speaking the whole time about the process of inquiry: in a curious way his intentions regarding an open-ended process leading to final attainment of inquiry is quite easily overlooked. Furthermore, although Goethe is letting us peek into his methodological workshop, he is not telling us all. In his effort to stress the objectivity of his method he is at pains, as mentioned, to sever any obvious links to the arts. Not only does his effort to underline the objectivity of his scientific method make it difficult to see the importance of the details of the process of inquiry, his essay also makes it exceedingly difficult to propose links between his notions of scientific and artistic method. Goethe almost implies that the artist has no method worthy of the public's attention when, at another point in the essay, he suggests that it is best for the artist to remain quite silent about the workshop of his method:

Man hat in den wissenschaftlichen Dingen gerade das Gegenteil von dem zu tun, was der Künstler rätlich findet: denn er tut wohl, sein Kunstwerk nicht öffentlich sehen zu lassen, bis es vollendet ist, weil ihm nicht leicht jemand raten noch Beistand leisten kann ... (*41*, 8).

This is the more curious since Goethe speaks elsewhere quite openly and in-depth about the issues of aesthetics. Naturally, Goethe is campaigning in this essay for more openness and reflection on methodology in scientific circles. Goethe is also referring here to the publicizing of unfinished literary works, and not directly to aesthetic method. None the less, it is easy to misunderstand this remark of Goethe's as a downplaying of aesthetics to the benefit of the scientific method. Moreover, even given Goethe's rhetorical needs here, it is precisely the combination of his scientific works and his work on aesthetics that leads Novalis to praise Goethe for his "active empiricism". The link between Goethe's aesthetic and scientific method, however, can be found, but it is couched in mathematical terms: once again, it would appear to throw the reader off the scent. The link lies in the following statement where Goethe refers to the "higher experiences" gained by the accumulation, refinement and reduction of a series of experiments:

Eine solche Erfahrung, die aus mehreren andern besteht, ist offenbar von einer höhern Art. Sie stellt die Formel vor, unter welcher unzählige einzelne Rechnungsexempel ausgedrückt werden ... Diese Bedächtlichkeit, nur das Nächste ans Nächste zu reihen, oder vielmehr das Nächste aus dem Nächsten zu folgern, haben wir von den Mathematikern zu lernen (*41*, 13).

Lenoir comments on this remark of Goethe's:

Goethe saw this method as analogous in the experimental domain to the method whereby a mathematician, through an act of intellectual intuition, seizes upon the formula that links the various statements of proof into a necessary unity, the logos that enables him to see the individual components of the proof as aspects of the whole (*235*, 123).

Lenoir's reading, while correct at the level of a direct interpretation of the text, does not treat the full implications of the context. Lenoir's wording can be misunderstood; it almost sounds as if the "higher experience" alone brings order to the series of experiments. Sepper offers a subtler reading of *Der Versuch als Vermittler* by stressing that the "higher experience" is based upon a fundamental experience:

For instance, each isolated experience of looking at objects or displays through the prism gives a single "fact" to be reckoned with. But by means of constant comparison, contrast, simplification, and recomplication, Goethe is able to represent these many apparently isolated facts as different moments of a single dynamic phenomena, moments that correspond to the varying conditions of the basic experiment (*276*, 69-70).

Sepper here rightly stresses Goethe's view that the "higher experience is linked to an initial experiment - this brings out the phenomenal base of Goethe's notion of the "higher experience". Further, Sepper reminds us that Goethe's argument for a sequence of experiments that lead to the "higher experience" lies in his concern for "a naturally significant order" of the phenomena in experiments (*276*, 76). What Goethe refers to as the mathematical method is his view, as Sepper summarizes, that the demonstration of experiments "must be so consequent that any gap in the demonstration will be immediately obvious" (*276*, 77). The mathematical method, in Goethe's view, is analogous to his own experimental method since it concerns itself more with "Darlegungen, Rekapitulationen als Argumente" (*276*, 14). Sepper emphasizes that Goethe is concerned, first and foremost, with methodology and not theory itself. It is Goethe's concern for the phenomenal and experiential that underlies his view:

No matter how good the fit, the observed phenomena ought not to be supplanted by an abstract theory, for, at the very least, knowledge about how one is to apply the theory is itself metatheoretical and therefore metamathetical. Goethe's method, to demonstrate through judicious experimentation phenomenal wholes that unify the appearances - to elucidate the form and structure of the phenomena - is a prequesite for the scientific application of mathematics (*276*, 76).

The other meaning behind Goethe's reference to mathematics, as Sepper comments, is the notion of an infinite series: "The superexperiment, whether continuously or discretely varied, allows one to approach phenomenally a limit that may not be reachable in fact ..." (*276*, 74). The fundamental experiment or the "higher experience" can be interpreted as an "upper limit" towards which and within whose bounds all experimental inquiry in the given field is oriented. Sepper is concerned with Goethe's colour theory, but phenomenal "upper limits" are also manifested in Goethe's notion of the "Urpflanze", the intermaxillary bone, and the notion of chemical affinity. It is in the notion of a phenomenal infinite series that an overarching conceptual view of practice can be found in Goethe's work - a notion that links aesthetics and scientific method. If we return to Nisbet's view that Goethe unified empirical and Neoplatonic elements in his notion of a series of experiments, the meaning of scientific inquiry conveyed in *Der Versuch als Vermittler* can be better understood in terms of a type of "phenomenal" calculus. Nisbet remarks:

> The same Leibniz who propounded the principle of continuity also invented, independently of Newton, the differential calculus, whereby continuously varying quantities in the physical world could be expressed in mathematical language. Goethe, too, believed that the data furnished by experiments should be presented in continuous series, except that, in this case, the series is one of gradual visible distinctions rather than gradually varying quantities (*249*, 38).

It is the notion of the use of experiential concepts in a "phenomenal" calculus that links Goethe's views on the sciences to the arts. It is a general symbolic method, not only a scientific method. In this light, Goethe's notion of inquiry anticipates Novalis's notion of treating inquiry "symbolically". Not only do both Goethe and Novalis view inquiry as having to move outwards from fundamental phenomena, and then, through "Vermannigfaltigung" (Goethe) or "vervielfältigen" (Novalis) come ever closer to a refinement of experimental results into a "phenomenal" form of theory, but also, they both underline the symbolic method of inquiry in the general method of a "phenomenal" calculus. The relevance of the Neoplatonic notion of continuity taken up by Leibniz will be discussed below (see chapter two, section 1.8). Essentially Romantic notions of continuity and experimental methodology express a phenomenalization of Leibnitz's notions of continuity and notation in mathematics. Herder too argues for the principle of continuity (*249*, 8); his notions of knowledge formation in his *Plastik* could then, perhaps, be extended to the idea of a phenomenal form of notation. Thus, the Romantic use of the Neoplatonic notion of continuity can be seen as a qualified response to the needs of empirical science. The analysis of the influence of Plotinos on Novalis in chapter two will bring these various threads of Neoplatonism, empiricism and Romantic thought together in more detail.

For whatever reasons *Der Versuch als Vermittler* was not published until very much later after its inception. One reason, clearly, is Goethe's fear of an attack on his scientific method, another reason lies in some of the above anomalies discussed relating to the links of aesthetic and scientific method. Even Schelling stops short of directly linking scientific and artistic methods of production. As discussed art is an extension in methodological terms of philosophy, and art has the ultimate objective status. In terms of knowledge formation there are however scientific modes of production which have aesthetic elements, as has been shown with the Schelling's use of "Zwischenglieder". Thus, although he does stop short of directly linking scientific and artistic methods in his *System*, he by no means denied the link, since there are tacitly accepted bonds formed in his philosophy. Novalis's notes on the subject were, of course, private. It is through the uncovering of these private or tacit thoughts that this work, as mentioned, wishes to put forward a new understanding of the early Romantics.

Having spent considerable time on explaining the concept of experiment and the epistemology of practice typical of the early Romantics, it is now appropriate to tackle the realizations of their method in scientific theory and this form of theory's relationship to natural history. Romantic scientific theory, as espoused in the notions of types and ideal types, needs to be placed both in the context of their notion of practice and in that of the natural history of their time.

The Romantic idea of experiential knowledge has so far been taken to mean representational forms of knowledge that mediate between theory and phenomena within the scope of the purposive processes of Nature. Ideal types also fall into this category of knowledge, but in a heightened sense. Ideal types are the experiential notions that are the ultimate forms, forces or causes of natural phenomena. These ultimate phenomena transcend temporal history since they are fundamental to an understanding of phenomena throughout time. Ideal types can only be understood as part of the process and continuum of Nature. Schelling's "gemeinschaftliches Ideal" (common ideal), Novalis's notion of a "Kraft" (an original force), or Goethe's "Urpflanze" (primordial plant) transcend history, because, like their common natural philosophical method, they are part of history in the making. Within the context of the ideal type it will also be shown, for example, that Werner's geognosy embraces notions which lie within the scope of a Romantic idea of "Naturgeschichte". In doing so, Werner's geognosy incorporates thoughts which certainly go beyond Kant's idea of descriptive natural history ("Naturbeschreibung"), and also beyond Kant's idea of natural history ("Naturgeschichte").

Kant is unwilling to employ ideal types that transcend time (*235*, 124). Schelling's notion that an ideal is realized throughout the whole of the processes of nature is quite opposed to Kant's notion of a "Naturgeschichte" as a genealogy where stem-kinds ("Stammgattungen") are only to be found in the past (*210*, 29, 39). Schelling remarks in his *Erster Entwurf eines Systems der Naturphilosophie*:

Die Naturgeschichte ist bis jetzt eigentlich Naturbeschreibung gewesen, wie Kant sehr richtig angemerkt hat. Er selbst bringt den Namen Naturgeschichte für einen besonderen Zweig der Naturwissenschaft, nämlich die Kenntniß der allmählichen Veränderungen, welche die verschiedenen Organisationen der Erde durch Einflüsse der äußern Natur, durch Wanderungen von einem Klima in das andere u.s.w. erlitten, in Vorschlag. Allein wenn die oben aufgestellte Idee ausführbar wäre, so würde der Name Naturgeschichte eine viel höhere Bedeutung bekommen, denn alsdann würde es wirklich eine Geschichte der Natur selbst geben, nämlich, wie sie durch continuirliche Abweichungen von einem gemeinschaftlichen Ideal - insofern also frei - deswegen aber doch nicht gesetzlos bildend - weil sie doch beständig innerhalb der Grenzen ihres Ideals bleibt - die ganze Mannichfaltigkeit ihrer Produkte allmählich hervorbringt, und so das Ideal zwar nicht im Einzelnen, aber doch im Ganzen realisirt (*108*, 68).

With his notion of the "gemeinschaftliches Ideal" - an example of an ideal type at the highest level as a first cause - Schelling argues for a history and development of forces, and this Kant was not prepared to do. As remarked, the ideal type is neither temporal nor atemporal, it transcends time in being part of the continuity of the process of Nature.

Moreover, Kant's notion of an organic life force is based upon Blumenbach's (1752-1840) notion of the "formative drive" ("Bildungstrieb"), and this is a regulating vital force (*235*, 121-122). This force is opposed to Schelling's concept of a force that actually causes matter. Schelling's notion of force here refers both to his original force and the role forces play in general in his natural philosophy, for his forces preempt matter. Using analogies and the principle of polarity, Schelling contructs a view of Nature that navigates beyond Kant's views of science and natural history. Admittedly, in his later critical works Kant's notion of teleology suggests that one can proceed beyond descriptive natural history by assessing similarities in anatomical structure. Lenoir remarks on Kant's teleology of the organic realm:

> He [*Kant*] argued that the agreement of so many species, not only in their skeletal structure but in the organization of other parts as well, suggests that they might all be united by a fundamental ground plan (*235*, 122).

Within this teleological framework Kant believes it possible to go quite far in explaining organic forces with the use of physics and chemistry (*235*, 122). In his notion of natural history, Kant blends together the use of mechanical laws with his notion of "Naturzwecke" (natural purposes) in the organic realm. Thus the study of mechanical linear causes is combined with the study of final organic causes within the field of comparative anatomy (*235*, 120-122). However, Kant's views on teleology categorically do not propose a history of forces or a study of ideal types in the Romantic sense. Kant's notion of morphological types is temporal (*235*, 123-124; *210*, 39). The possibility of proposing ideal types is inextricably bound up with the questions of method, epistemology and perception: here Kant's views also had a role to play. As discussed, in his *Kritik der Urtheilskraft*, Kant considerably expands his philosophy from the subjects dealt with in the *Kritik der reinen Vernuft*. In the later work Kant speculates on the powers of the intellectual intuition to grasp the inner workings of the natural world. This work was read by thinkers such as Goethe, Schelling and Novalis, and it undoubtedly influenced them; none the less Kant is not willing to apply the powers he speaks of to the sciences. Their relevance to the sciences, in his view, remains within the realm of the regulative or of speculation.

An overview of Goethe's notion of the "Urpflanze" will serve to depict an approach to natural history and their use of ideal types which can also be regarded as typical of the early Romantics. It will, furthermore, serve as an introduction to Humboldt's biogeology.

Goethe's chief approach to the sciences can be described as morphological, but, given his concern for method, it is more precise, at an encompassing level, to refer to his approach as typical of the Romantic quest for symbolic knowledge and a "phenomenal" calculus. Goethe's key terms in his scientific works are "Urphänomen", "Gestalt", "Typen", "Metamorphose", "Analogie", "Polarität", "Steigerung" and "Compensation". The notion of the "Urphänomen" conceives of nature as a whole; the "Urphänomene" bring forth the forms in the natural world, as for example, of plants or of light. Goethe's view of the "Urphänomen" is to a large extent based upon the Neoplatonic ideas found in Bruno and Leibnitz surrounding the notion of the monad. The monads are individual entities forming part of the greater entity of Nature. Goethe uses the symbol of the processes of breathing, the "Diastole" and the "Systole", to explain his own view of the monad. In his view of plants and animals there takes place a continual contraction ("Zusammenziehung") and extension ("Ausdehnung"), analogous to the continual process of breathing in and breathing out (*243*, 58-59). In Goethe's eyes the monad develops in its own right and also reacts to its environment. The way the monad comes into being is analogous to all areas of life - as is epitomized by the rhythm of contraction and extension. Goethe's idea of the monad is a development of Aristotle's entelechy, of the notion of the unchanging form of Bruno's monad, of the closed windowless monad of Leibnitz and of the latter's notion of a pre-established harmony. The harmony of the individual and the ability of the individual entity to change are united in Goethe's notion of the monad (*243*, 58-59; *249*, 19-22). Within the context of the monad one can say that particular plant forms are varied throughout the plant world. Within each plant lies the potential to develop upon the fundamental plant form of the "Urpflanze"; the plant's development can be put down to this inner potential and its adapting to a particular environment (*243*, 95).

The "Urphänomene" are the final stations of Goethe's ideal phenomenal inquiry. They are the results of the various levels of phenomena, investigated in observation and experiment, reduced to their most fundamental form. For Goethe the botanical "Urphänomene" are the "Urpflanze" and the leaf. The plant organ which makes the "Urpflanze" real is the leaf: Goethe sees the leaf as the plant form upon which all other organs of the plant are varied through the processes of contraction ("Zusammenziehung") and extension ("Ausdehnung"); all other organs are analogs of the leaf. The leaf is an extension of the stalk; the sepal is the contraction; the petals are an extension; the generative organs are a contraction; the fruit are the final extension. The whole development is viewed by Goethe as a process of "Steigerung" (enhancement) and also as the metamorphosis ("Metamorphose") of the leaf. The process is further viewed by Goethe in terms of "Polarität" (polarity), which provides the continual attraction and repulsion inherent in things. This fundamental tension of "Polarität" is then employed by the principle of enhancement to bring about further development in plant forms (*243*, 104-106).

Goethe's views on ideal types are sometimes misunderstood as being merely "ideas", but this is not the case. The leaf is real, just as the "Urphänomen" of turbid light (*249*, 41). Admittedly, Goethe began with the idea of the "Urpflanze", but he then moved on to employ real "Urphänomene". This is important to modify Kantian interpretations of Goethe (*213*; *260*, 146), and to emphasize the epistemology of practical knowledge that underlies the notion of the "Urphänomen". Goethe's ideal types are phenomenally based and thus enable the employment of a "phenomenal" calculus.

Humboldt's close relationship to Goethe and the latter's notions of morphological and ideal types can be clearly traced in his biogeology. In his 1806 *Ideen zur Physiognomik der Gewächse* (*57*) Humboldt singles out seventeen plant types - such as grasses, palms, cacti, conifers, lianas, horse-tails, mosses and lichens - to which all plants belong (*243*, 140-142; 191 fn. 91/92; *247*, 182). By virtue of being based on vegetation and nutrition organs, and not on Linné's generative organ based taxonomy, Humboldt's taxonomy allowed for considerably more transitions between plant species and also for more room for "compensations" (*243*, 159). Both of these factors appealed to Goethe. The tight linking of phenomena through transitions adheres to Goethe's notion of experimental inquiry - in this case it is applied to the rules of observation and classification. Humboldt's notion that certain plant organs or physiognomic plant groups could be varied at the cost of other members of the plant type is a biogeographical extension of Goethe's notion of "Compensation" for the morphology of organs (*243*, 160-162, 191).

Humboldt's work is of great significance for an understanding of a Romantic epistemology of practice, not only through his definition of ideal plant types but also because of his employment of a visual language in his works. Before he undertook his expeditions, Humboldt expressed an interest in what he called "Pasigraphie" (literally: general sign language). Humboldt's notion of "Pasigraphie" closely resembles Novalis's notion of the "Instrumentalsprache": a language both of the mental tools employed in investigating phenomena, and also a visualization of literal scientific instruments used in experiment and observation.

Humboldt's first attempt at a such a sign language - in his 1797 work on galvanism - was highly abstract (*54*). He drew up formulae for galvanic circuits, denoting conductors as letters (*54*, 89-100). Although his work in the area of chemical physiology was something of an achievement, it did not lead to a discovery as significant as Ritter's, where physiology and galvanism were experimentally linked, nor, arguably, was his sign language as developed as Ritter's was for treating galvanic phenomena. In fact, Ritter's sign language can be seen as the insertion of formularistic features into diagrams. Even given his valuable findings in galvanic inquiry, Humboldt's major achievements were really in the area of biogeology, and it is in this area, where he was a master, that he developed his visual language. Humboldt's all-embracing biogeological reliefs are well known: on a single sheet a vast variety of information concerning climate, vegetation and other factors are comprehensively displayed. His achievements in the bounds of what he termed "Pasigraphie" are less well known. Whilst his biogeological reliefs employ names, tables and often mimetic-realistic diagrams, his one existent pasigraphic chart of 1803 (elaborated on in 1832) employs genuine symbols which hover between the abstract and the mimetic (see *Fig. 2*). Humboldt's pasigraphy treats not biogeology but geognosy, and this brings traditions and influences into play other than Goethe alone.[28] The pasigraphic chart of Humboldt's displays rock strata in terms of types: the chart can be seen as the morphology of strata. The source of influence on this morphology may be sought, arguably, in the geologist Werner, under whom Humboldt had studied. Humboldt's pasigraphic chart depicts various rock formations in a semi-abstract way with a legend providing the key to the formations (*137*, 246). The pasigraphic chart of 1803 was a part of Humboldt's thought to which he often returned in his later geognostical writings (*136*, 35; *58*, 364-375; *60*, 1, 457). In 1832 he introduced arrows to the chart of 1803 to convey further aspects of geognostical theory. Rock formation caused by precipitation and erosion is termed "exogen" by Humboldt and is depicted by a downwards pointing arrow. Plutonist and Vulcanist theories of igneous rock formation are described by Humboldt as "endogen" and are depicted by upwards pointing arrows (*136*, 35; *137*, 246). The combination of rock strata abstractions and the arrows, like his biogeographical reliefs, lead to a dense and informative presentation of ideas. In this visual language of Humboldt's we once again find the Romantic notion of a "phenomenal" calculus: it is the symbolic method of treating phenomena, based upon experiential types, depicted for example in the symbolic, semi-abstract

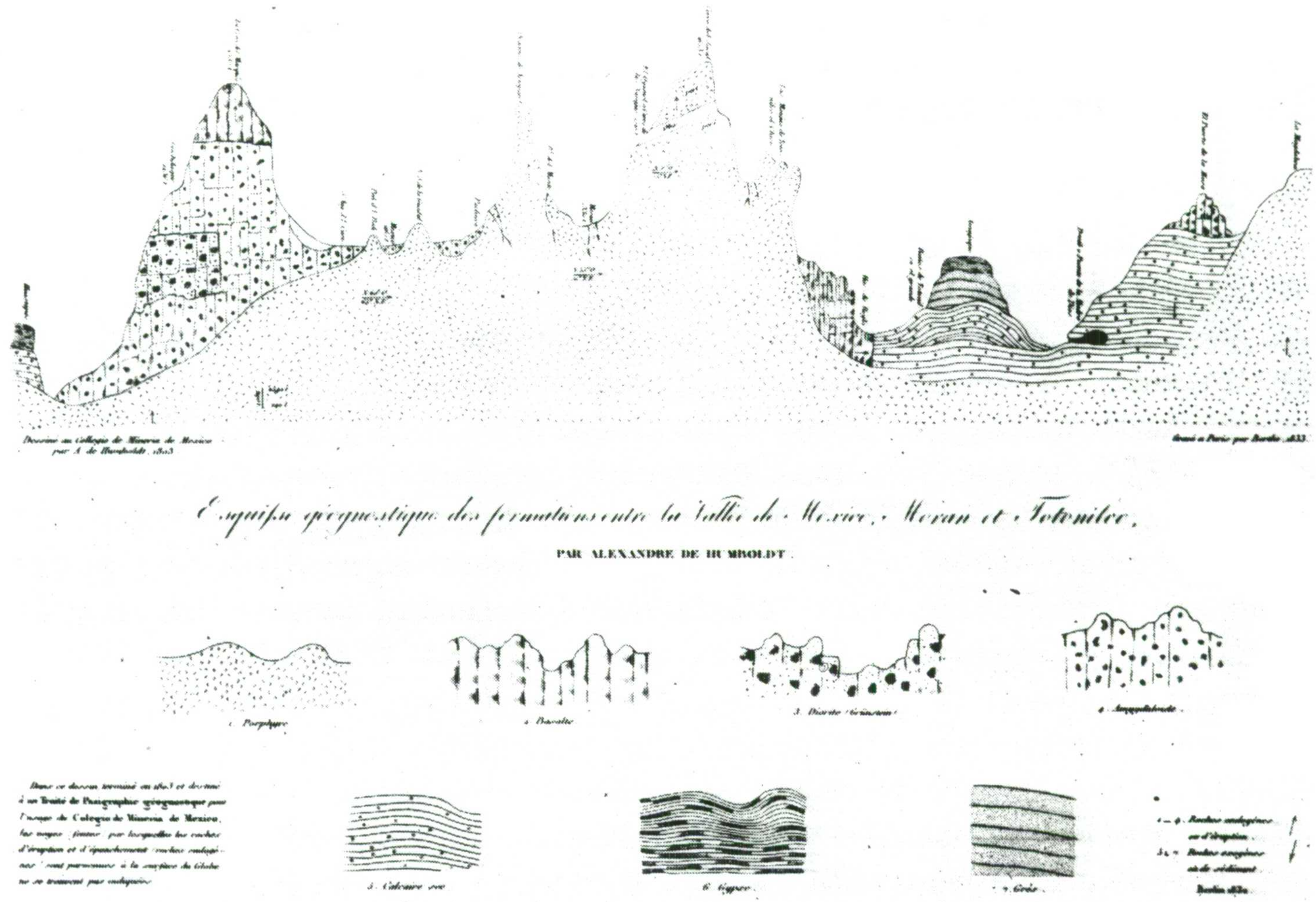



Fig. 2. *Humboldt's pasigraphic scheme, 1803/1833*

characteristics of Ritter's galvanic diagrams. Humboldt's pasigraphic chart is not mimetic, nor abstract, but what can be called "concrete". Humboldt's geognostical arrows in his pasigraphic chart are related at an epistemological level to Ritter's galvanic arrows in his diagrams of galvanic experiments. Both their arrow forms are symbols of natural processes. That Humboldt, as Ritter too, understood his symbolic language as an attempt at a "phenomenal" language of Nature itself can be seen when he speaks in his 1803/1804 *Essay de Pasigraphie* (*56*) of his wish to express geognostical phenomena only in eighteen signs, in an analogous way to the manner in which human thought is expressed in the twenty-four letters of the alphabet:

Je m'arrête à 18 characteres qui me suffirent pour former un Tableau geologique tel qu' avec 24 lettres d'alphabete nous exprimons toutes nos pensées (*56*, 39).

The entirety of the language of geognostical phenomena can be reduced to eighteen natural types.

As already commented, Humboldt's pasigraphy has received little attention from historians, apart from Beck.[29] Beck points to Humboldt's own reference he makes to the geologist's concerned with formation, Lehmann (1713-1767), Whitehurst (1713-1788) and Ferber (1743-1790) (136, 34). Humboldt's pasigraphy has a deeper tradition than this. Although the geologists mentioned did concern themselves with formation, Humboldt's pasigraphic depiction takes strata charts on quite some way. Whitehurst, for example, like Humboldt, is concerned with vertical depictions of the interior of the earth, in contrast to the traditional method of using horizontal coloured charts of the earth's surface. Humboldt split his mapping projects up into two groups: those concerned with strictly scaled vertical profiles ("Höhenkarten") and those depicting rock formation ("Formationskarten"), where strict scaling was discarded for the benefit of the explication of formative processes and strata. The symbolism of Humboldt's pasigraphic chart is more complex than those of previous stratigraphic charts, and, above all, his use of arrows to depict two cardinal modes of rock formation recalls the Romantic use of key types. Clearly, all the strata depicted can be viewed as types, but it is the formations depicted by the arrows (the "endogen" and the "exogen") that are the original types common to all the types. The arrows depict what Goethe would call "higher experiences" such as are manifested in his "Urphänomene".

In this context, it is a pity that Rudwick's stimulating essay on the visual language of geology concerned itself predominantly with Great Britain and France (*268*). There is a missing link here in Rudwick's account, and it may be that the Germans had some role to play in the development of the visual language of geology, but only tentative suggestions can be made here on this topic. As remarked, Humboldt's diagram of 1803 forms a significant jump in stratigraphic mapping. Another source of influence on Humboldt's diagrams has to be found other than the geologists mentioned above by Beck. Furthermore, in Rudwick's account there is little that is applicable to Humboldt at this time. In Rudwick's delineation of the visual language of geology there is a time gap between Whitehurst's stratigraphic diagrams of 1778 (*127*) and those of Farey in 1811 (*27*), Cuvier and Brongniart of 1811 (*21*), and Smith in 1817 (*114*). Humboldt's source may well lie close to the mining academy in Freiberg, as for example in Trebra's (1740-1819) work of 1785, *Erfahrungen vom Innern der Gebirge nach Beobachtungen gesammelt* (*118*), or in Voigt's (1752-1821) work of 1782, *Practische Gebirgskunde* (*119*), although the latter is sparsely illustrated.[30] Trebra, who was sub-director of the mines at the Mining Academy in Freiberg, on the other hand, is a significant exception in the history of geological illustrations. Rudwick points out that geological illustration only took off in the 1820's with the arrival of cheap wood engraving - up to then the visual language of geology was under financial restraint (*268*, 154-158). Trebra's work, however, contains five "Vignetten" and sixteen engravings: within these are a variety of illustrative approaches, ranging from the realistic to the abstract, including maps of mines and their sections, details of rocks, area maps with some profile depicted, and stratigraphic diagrams.[31] There is nothing in these visual techniques as complex as in the work of Humboldt in 1803 or the work of Cuvier and Brongniart in 1811 (there could not be, given the status of geognostical theory at that time). Trebra was, however, aware of the power and use of illustration, and argued that his illustrations were every bit as evocative of the powers of nature as the conventional and fashionable pictures of volcanoes, for they portrayed objects "wo die Natur, wenn gleich stiller, geräuschloser, und langsamer vielleicht, dennoch aber nicht weniger mächtig, allumfassend, und Ehrfurcht erweckend wirkte ..." (*118*, vi). Trebra is referring to the inner processes of the earth, which were soon to be the subject of Werner's *Kurze Klassifikation der verschiedenen Gebirgsarten* (*125*) of 1787.

This leads us to one major influence on Humboldt, that of Werner. The extent to which Werner effected Humboldt in terms of visual language is difficult to pinpoint: Werner did make use of stratigraphic sketches in his lectures at the mining academy (*289*, 98-105). More influential than such sketches, however, are probably Werner's geognostical notions, which, as forms of ideal types, lend themselves to interpretation in terms of visual and experiential forms of knowledge. The teachings of Werner form perhaps the missing link in Rudwick's history of the visual language of geology, and it will now be argued that Werner's influence went far beyond doctrines of geology to the practical knowledge of geological theory.[32]

Within Werner's geognosy lie the seeds for a history of natural forces in the inorganic realm and the rudiments of a framework within which geognostical ideal types can operate. Werner divides rock strata into two main groups: the "Kieselreihe" ("siliceous acid" - i.e. siliceous earth) and the "Kalkreihe" ("carbonic acid" - i.e. carbonate of lime). This division into two groups is of great import for a natural philosophical interpretation of geognosy. The two groups firstly form a typical Schellingian polarity with which the forces of Nature can be constructed. Secondly, the two groups are linked to chemical forces. The "Kieselreihe" corresponds to oxidized matter and the "Kalkreihe" to deoxidized matter (*173*, 499; *116*, 8-15). Thus, in Schellingian fashion, a constructive analogy is made between forces of one realm (the chemical/physical) and another (the geognostical realm). Fritscher points out that although no work of Werner's explicitly refers to these links of the chemical and the geognostical realms, Werner did in all probability hold lectures on the subject. Furthermore, Werner's pupil, Fuchs (1774-1856), formulated a theory of the earth based on such principles and did so with explicit reference to Werner's views on geognosy (*173*, 500; *32*). Thirdly, the link of geognostical and chemical forces in turn implies an attempt at the construction of the history of forces, moving from the small scale of the chemical realm to the large scale realm of geognosy. Rupke, too, points to the latent natural philosophical implications of Werner's geognosy and also to the notion of a "directionalism" of forces implicit in his views (*269*, 251-252). Fourthly, a fundamental principle for "Naturphilosophie" is implied and proposed: that of chemical affinity. The ultimate cause behind Werner's geognostical theory is that of chemical affinity since that is the force that governs the oxidization and deoxidization of matter (*173*, 499). Within the context of Schelling's natural philosophy it should be noted that although he argues for oxygen as a key natural philosophical principle, as for example in his *Ideen*, he does also there see cohesion ("Kohäsion") and affinity as key principles (*164*, 26-30). In his 1801 work, *Darstellung meines Systems*, Schelling states:

Der chemische Proceß, in seiner Ursprünglichkeit, beruht einzig darauf, daß zwei differente Körper durch Berührung wechselseitige Cohäsionsveränderungen in sich setzen, und jeder derselben seinen Zustand auf Kosten des Indifferenten wiederherstelle (*112*, 184).

The notion of "Kohäsion" forms the basis of his view that the whole of matter can be seen as an infinite magnet, and of the corollary, that matter evolved from the original substance of iron (*129*, 138-139; *112*, 157). Werner's geognosy, when seen in the light of Schelling's natural philosophy, breaks the bounds of both Kant's "Naturbeschreibung" (descriptive natural history) and "Naturgeschichte" (natural history). For his geognosy suggests a history of forces through its linking of analogous processes in chemistry and geognosy, and in the way it promotes the fundamental principle of affinity as the cause behind geognostical phenomena. The notions of affinity and the two major rock groups can be interpreted as the Romantically styled ideal types of Werner's natural history.

All these aspects of Werner's geognosy have been shown by Fritscher to have been taken up by Steffens (1773-1845). Steffens took Werner's ideas and applied Schelling's method to them and made their Romantic natural philosophical implications explicit. Fritscher further points out how Steffens extended Werner's above views on geognosy to the organic realm (*173*, 500; *116*, 27, 29, 32, 34, 91). Steffens again does this in Schelling's style of natural philosophy through the use of polarities and analogies. This step in Steffen's interpretation of Werner's ideas probably went beyond Werner's intentions, but the other aspects of Steffen's interpretation of geognosy do reflect Werner's concern for forces in nature, both at the strict chemical or physical level and at the geognostical level. It cannot categorically be said that Werner was conducting natural philosophy in the style of the Romantics. The reason that we cannot categorically state this is because Werner never did lay down a complete theory of the earth from which we can draw direct conclusions about his natural philosophical views. What can be said is that Werner worked with particularly significant analogies and used them within an implicit framework of a purposive natural world: when this framework is expanded and taken to its logical consequence it has a strong appeal to the Romantics. Thus Werner's importance for the Romantics lay not alone in his natural history, i.e. as a particular theory, but also in his approach to theory, i.e. his method. It is firstly in his method and his use of key experiential concepts that Werner shows an explicit affinity to the styles of thought found in Novalis and Schelling. Secondly, as with the Romantics' view of forces and phenomena, method and theory are anyway bound together in Werner's mineralogical and geognostical ideas. In Romantic notions of purposiveness in Nature attempts are undertaken to explain "how" Nature develops, that is to say, the Romantics strive to find Nature's own "method". Schelling's ideal "Funktion" or "Thätigkeit" and Novalis's notion of Nature's own representational powers are definitions of Nature's own intelligent formative force. The often presumed poles of method and theory or of mind and matter are united in Novalis's and Schelling's thought through their proposition that man and Nature are governed by the one and same purposive force. In this way Novalis's notion of representation applies equally to Nature as it does to human knowledge. In his idea of the "Figur" Novalis speaks of the same power of representation, be it in human "figures" of thought (i.e. the practice of thinking in symbols in experiential knowledge) or in the "figures" (forms) phenomena produce in their activity (*N*, 3, 123, 612). Equally, in this light, the possible effects of Werner's experiential approach to theory on Humboldt's notion of a geognostical sign language - as the language of Nature's geognostical phenomena and forces - become more justified. Humboldt's own symbols of his pasigraphy are manifestations of Nature's representative powers.

Furthermore, with Werner, it can be argued that notions of purposiveness in Nature come readily to light in his method and even in his personality, and not only in his views of geognostical phenomena. The sensual way Werner treated the study of minerals, for example, implied that the inquirer had direct contact to the laws and forces of the natural world. The way Werner could transfer this type of sensual knowledge into a theory based on experiential principles implies a link between the inquirer's theorizing capabilities (the mind) and the objects under observation (matter). In other words, it is the tacit and practical knowledge that Werner espoused that also influenced the Romantics, and not his notions of mineralogy and geognosy alone. The distinct way in which Werner's method was concerned with the formation of knowledge and discovering constitutive, open-ended rules is of importance here. Since, in Novalis's view, it is through method and practice that wisdom is transferred it can be said that those who understood Werner's method were already formulating his probable theory. In Werner's work lies already the mixture of practical (ethical) knowledge and science that the Romantics were seeking. It can be said that Werner sought to give his students not "episteme", but "phronesis", or to be precise, Werner sought to blend "episteme" and practical knowledge.

A comparison with Lorenz Oken, a man whose work can be seen as an extension and adaption of the early Romantics, will serve further to define the early Romantics' notion of practice. Oken's work, although bearing similarities to the views of the early Romantics, also reveals some considerable differences. Attention has already been drawn to Schelling's increasing concern for practice in his natural philosophical works up to 1801 after his *Ideen*. Schelling problematizes the issues of practice and in this way he possesses similarities to other thinkers such as Goethe and Novalis in their quest for a reliable method. Schelling draws a subtle frame around the questions concerning the links between mind and matter, firstly by arguing for links in terms of analogies (e.g. the analogies between the moments of Nature's history and the moments of human thought), and secondly by posing questions as to how such links could at all be possible. He carries out the latter by constructing a philosophical base that accounts for human thought as part of the greater processes of Nature, as espoused in his notion of the "Weltseele". Oken takes a far more definite stance towards natural philosophy in his notion of "Mathesis". Quite remarkably, he systematically presents a highly comprehensive natural history of spirit and matter in Nature. Although Oken does lay emphasis on experiential knowledge and "experiment" in his notion of natural philosophy, he foregoes the problematizing of the notion of experiment which is involved in searches for methodological positions. Instead Oken wishes to let experiment and theory interplay far more directly under the guidance of his notion of "Mathesis". Oken views "experiment" in terms of empirical knowledge that is taken for granted; speculation is viewed in his system of knowledge as a necessary pole of empirical knowledge. Nevertheless, as mentioned, experiment and speculation interact closely with one another in Oken's view. Instead of attempting to resolve the problems of experiential or practical knowledge through problematizing, Oken views "experiment" as an information source ("eine reine objektive Erfahrung") for his notion of speculation, and speculation, in turn, is closely linked to the ground of knowledge in experience and experiment. Oken thereby views experiment and speculation in terms of a closely knit knowledge process. In his work of 1802, *Übersicht des Grundrisses des Sistems der Naturfilosofie*, Oken states:

> Den Geist zu finden sei unser höchstes Ziel, nicht erstes. Das Experiment ist das Erste. Ich glaube, daß dadurch der Werth des Experiments sowie die Würde des menschlichen Geistes gesichert ist ...Die Spekulazion thut Verzicht auf ihre Anmaßung für sich ohne Erfahrung zu erfinden. Das Experiment bescheidet sich mit der Gediegenheit und Reinheit des Schauens und stolz den ersten Platz zu behaupten, die Basis des Gebäudes zu sein überläßt sie den höchsten Platz und die Spitze der Pyramide dem Geiste. So ist alles an seinem Platze; die Spekulazion ruhend auf den festen Gebäude einer rein objektiven Erfahrung (*79*; *225*, 38f.).

Oken's "Mathesis" is then placed above experiment and speculation as a guiding structure within which experiment and speculation operate. This "Mathesis" is divided up into two parts: "Pneumatogenie" (the science of the immaterial whole) and "Hylogenie" (the science of the material whole) (*259*, 57-58). His "Mathesis" presents the arithmetics of the exchange between matter and spirit; its aim is to delineate the identity of matter and spirit. Oken derives the entirety of phenomena from the original zero, God. Below "Mathesis" in Oken's system come "Ontologie" (the study of individual appearances or things) and "Biologie" (the study of the effects of the spirit in individual things) (*80*, I, viii; *259*, 57-58). In his "Biologie" Oken's "Mathesis" finds its strongest role, since it is the aim of his "Mathesis" to systematize known phenomena and to predict unknown phenomena. In this way for example, Oken wishes to use the number and hierarchy of plant organs to ascertain the number and hierarchy of plant classes (*259*, 65). He goes further, given the ordering of the plant classes and their subgroups, to calculate the total amount of plants in the world, and arrives at the figure of 65 536 (*259*, 65).

It becomes clear that Oken's natural philosophy, although firmly rooted in early Romantic thought, is a considerably different undertaking, both in terms of epistemology and in terms of a natural philosophical system. Thinkers such as Goethe, Novalis and Schelling are more concerned with showing the links between mind and matter or inner and outer nature through questions posed around the genuine problems of practical knowledge. If they do show physical links of mind and matter - as for example in the reality of their ideal types - then this is only undertaken in a piecemeal way in comparison to the sweeping systematic representation of the links of spirit and matter in Oken's natural philosophy. The early Romantic approaches to natural philosophy are far more akin perhaps to case studies in disciplines or areas of a discipline, guided by key natural philosophical principles, than full blown systemizations. Within their chosen areas - as, for example, Ritter's notion of galvanism, or Goethe's view of flowering plants - the early Romantics do lay claim to knowledge, but it is precisely at this point that they halt, for in the background of their natural philosophical activities there always looms the question of the reliability of their method, and, in essence, the very "experimental" nature of knowledge formation. The early Romantics are concerned at the lower level of the justification of knowledge, and only rise up to higher levels of formal theory if empirical results allow them to do so. Schelling's natural philosophical works under discussion here - those up to 1801 - can be also seen as setting the bounds of natural philosophical inquiry. Behind the works lies the permanent question as to how natural philosophy can be justified and the wish for experimental proof of natural philosophical notions.

In general early Romantic natural philosophy can be interpreted as the concern for the justification of fundamental experiential insights, such as Goethe's "Urpflanze", Ritter's view of the nerve in his galvanic theory or Schelling's insight into the identity of matter and spirit, or his notion of polarity. Moving outwards from these fundamental "Thatsachen", i.e. (in their view) key experiential notions, they move on to substantiate and elaborate them. In this way they are deeply concerned with the origins of knowledge and the need to keep the "phenomenal" origins of knowledge permanently in view. Their concern for the genesis of knowledge and method is of importance for the development of the disciplines where the danger of obfuscation of the original aims of the disciplines is only too readily apparent. In this way the early Romantics make a significant contribution to notions of consensus or knowledge formation since their works do dwell to a great extent at the level of methodology, and do test the ways nature, culture and thought can possibly be linked.

*5. Conclusion on methodology and premises. Summary of the issues of genre and practice for early Romantic natural philosophy.*

In the above discussion of the early Romantics' concern for practice, it has been shown how their view of the genre of experiment explicitly treats notions of discovery and knowledge formation: in "experiment" experience and theory are united. Their style of inquiry can be seen as one based upon as near as possible a comprehensive analysis of key phenomena (as mentioned, Schelling's natural philosophy can also be interpreted in this light in terms of the analysis of key insights). The process of inquiry involves variation, repetition, contrasting, simplification and re-complication of fundamental experiences and experiments.[33] One can speak of the early Romantics' highly descriptive style and the movement in their works to higher principles and open-ended concepts, and the combination and unification of laboratory experiments with thought experiments. Their experimental procedure can be viewed as a "phenomenal" calculus where rows of experiments are understood as operating according to fundamental phenomenon, or, as Goethe puts it, according to the "formula" of a "higher experience". It is in this overarching symbolic approach to knowledge formation that this work argues for a "tighter" conceptual link between the arts and the sciences, for the base of this approach to knowledge formation lies in a general concern for the issues of the practice of knowledge.

In terms of genre, literary or linguistic and aesthetic factors, early Romantic inquiry can, arguably, be viewed in terms of the tenets of Herder's *Plastik*. Language is treated as a whole, where groups of words, symbols and descriptions of groups of experiments lead to meaning, as opposed to discrete words, phenomena, experiences or experiments. In this way, for example, one can, perhaps, speak of three uses of language. Firstly, there is the inductive, plain and directly descriptive use of language (but this is not a reality, since, as argued, pure induction of knowledge cannot take place); secondly, one can speak of the formal, discursive or deductive and semiotic use of language, where language abstractly represents reality; thirdly, there is the "experimental", concrete-discursive use of language, where language is symbolic (i.e. concretely representative) of reality. In the latter use of language, in literary and scientific texts, symbols are used progressively and are varied to attain final meaning. The latter method applies to early Romantic natural philosophy and describes the importance of the genre of "experiment" and notions of practical knowledge in their natural philosophy. The way these fundamental concerns of the Romantics also apply to an "experimental" visual language of diagrams has been shown in Humboldt and is later dealt with in Ritter's use of diagrams. The use of a visual language in diagrams is a further aspect of aesthetics relevant to the study of Romantic genres. Novalis's notion of the "Figur" in fact embraces language in its broadest sense, treating language in terms of the symbolic, the phenomenal and the visual, and traces paths of meaning where ever it is possible in inner nature (the phenomena of human thought) and in outer nature (the phenomena of the outer world).[34]

This work aims to contribute to genre studies by examining the early Romantic use of the term "experiment" and their concrete-discursive, symbolic approach to language. This will, hopefully, provide some base for further studies of Romantic genres. Such studies would investigate further links between literature and science. The aphorism can be studied as a literary form affecting the sciences; or Novalis's notion of encyclopaedism could be construed as a project defining the symbols of the disciplines; or, further, it could be shown how Novalis conveys science and natural philosophical method to the public in his literary works. Underlying the early Romantics' views of language lies their chief concern for the history of practice of ideas and the epistemology of practice. In this concern, arguably, lies the form of consensus in inquiry pertaining to the early Romantic thinkers. In dealing with this aspect of Romantic thought the present work is thus not concerned explicitly with genre studies but rather with a differentiated approach to the history of ideas. This approach sees how the early Romantics are highly aware of the way ideas are taken over from tradition and pays close attention to the way these ideas are creatively used in practice. The Romantic use of the principles of continuity and notation in the Neoplatonic tradition are key examples of such a historical awareness and creative response. Tradition is viewed by the Romantics in terms of open-ended concepts which form part of the organicism of knowledge, and, in general as part of the purposive whole of Nature. Their own open-ended concepts, such as are found in their ideal types, are also seen in these terms as part of the tradition of practical knowledge. The other side of this work is linked to the previous and is concerned with a philosophy of practice as such - the unraveling of Novalis's epistemology of practice and its application in the main to Ritter and also, as an extension, to other Romantic thinkers as shown above. Thus, as a whole, this work is concerned with the practice of ideas, and that is why it does not deal with doctrines as such, but, in an "active" intellectualist manner, it treats the genesis of ideas. It considers how ideas are justified through practical knowledge in terms of discovery processes, epistemologies of practice and natural philosophical principles.

In its study of the early Romantics this work takes a wary path between two poles of relativism: that of the Romantics' unifying urge and that of open-ended practice, the latter being implicit in the treating of knowledge as a phenomenon. By examining their philosophy of practice and the empirical aspects of their ideal types the threat of relativism has, I trust, to a degree, been mitigated.

In terms of the accumulation of truth one can argue that Romantic science has posed many questions which are still unanswered today, that they began to answer some of these questions, but that our ignorance of the answers they sought should not obscure the validity of their inquiries. Such beginnings of key answers are to be found in Goethe's morphology, Humboldt's biogeology, Ritter's "constant galvanic force", and in the issues surrounding practical knowledge. These ideas were, in part, taken up by mainstream science: Ritter's ideas, for example, affected Oersted and Faraday. As concerns "experiment" and practice, these ideas merge with relevant issues today. In addition, their extension of practice to the ethics of science has also become highly topical. Goethe's views have been readily associated with the ecological movement. Within Humboldt's plant physiognomy, also, lie obvious ecological issues. Behind his notion of biogeology lies the idea that only a particular number of plant types can exist and that they exist at the cost of one another. This can be extended to the notion that the world has limits upon its resources and limits to its capacity to respond to effects on the environment. Ethics are part of the Romantic notion of natural philosophical inquiry: their inquiry attempts to meet Nature on her terms. Their attempts to seek Nature's language are readily apparent in their experiential approach to inquiry; in doing so they pay heed to the link of purposiveness in the inner nature of human thought and the external nature of the outside world. Novalis also makes remarks on what constitutes the "healthy experimenter", as will be discussed later - again, this can be seen to be concerned with the ethics of scientific practice. In fact, for the Romantics, practice in the more literal sense of knowledge formation is invariably linked to practice as ethics. This work argues that the early Romantic concern for practical knowledge is a major concern of theirs, and one of lasting value for us.

Finally, I wish to reflect on the value of Novalis's thought for intellectual history. In this introduction I have steered our attention to productivity as a general natural philosophical task, and I still maintain this view for several reasons. Firstly, the centrality of natural philosophy for Novalis (and other thinkers such as Goethe and Schelling) lies in the scope of their undertaking, which has to be seen in terms of uniting man's consciousness with the purposiveness of natural phenomena. Secondly, Romantic natural philosophy is an undertaking which points directly to the epistemological, religious and historical problems of modern science. Thus, Jardine, for example, refers to the manner in which man's faith now resides to some extent in the "juggernaut of science" (*210*, 236). Jardine comments:

> It seems that we have tacitly invested in the fate of science much that was once openly invested in sacred and spiritual histories of mankind with their promises of redemption and a millennium (*210*, 236).

In this context a recourse to Novalis's notions of natural philosophy means not only an examination of science in a discrete sense, but also of his notions of utopia, to see where science and utopia move in and out of their own debates. There is a strong case for studying Novalis in terms of natural philosophy in this broad sense. The "juggernaut of science", which was already taking up significant dimensions in Novalis's own time, has to be changed, in his view, into an interdisciplinary, imagination-oriented undertaking. Novalis's literature fits into this project as part of a broad programme of knowledge and "Bildung". His notion of "experiment", and indeed his own career as a mine inspector, show that his project was not without practical elements. Of course one must side with Neubauer and be cautious here: there is a gap between rhetoric and reality. None the less, I would argue that critical historical reflectivity is a dimension of Novalis's thought that should be taken seriously and is of use to debates on knowledge and the sciences, and, more obviously, of use to discussions on the relationship of literature to the sciences. As concerns the centrality of natural philosophy to Novalis's work, an attempt is made in this present work to approach this in an open and neutral manner by analyzing productivity. This hopefully makes this work more accessible to non-historians of science: this work provides links to literary theory, as has been seen. Arguably, however, the essential "genre" or category that is under study in this work is not that of language alone but the "genre" of practical knowledge and productivity. In analyzing issues of productivity this work's stance, as mentioned, is that of "active" intellectualism. It has been argued that although there are sociological elements in Novalis's thought the primary determinants are intellectual. Finally, to reflect once more upon the value of Novalis scholarship for intellectual history, it has been seen that his form of German Idealism is in many ways is a capable tool for attempting to bridge a variety of stances in debates over intellectual history. Novalis's ethics, aesthetics, notions of utopia, scientific method, natural philosophy and practical knowledge all offer up possible solutions or the beginnings of alternative approaches to the quandaries of intellectual history.

*6. Overview of Novalis scholarship relating to the context of the sciences, philosophy and aesthetics.*

The neglect of the topic of "scientific" reflectivity in Novalis scholarship can be put down to two salient factors. Firstly, it was the image of Novalis as an ethereal dreamer and the negation of Romanticism by positivist tendencies in the nineteenth century that led, perhaps understandably, to an emphasis on the artistic sides of Novalis's natural philosophy to the detriment of the scientific aspects of his natural philosophy. Dilthey set the tone here in 1865 in his work *Das Erlebnis und die Dichtung* by entirely discounting Novalis's thoughts on the sciences and by praising the originality of his notions on the "Wissenschaften des Geistes" (*310*, 212). Importantly, Dilthey's work was reprinted in 1905 and this affected Novalis research in the 1920's. Dilthey also drew upon Olshausen's short but disparaging work of 1905 (*341*; *354*, 150). Olshausen points to major sources in Novalis's thought such as Brown, Baader, Ritter and Werner; he finds too some aspects of Lull's and Leibnitz's notions of the *ars combinatoria* in Novalis's works, but his final view is that Novalis was not intellectually capable of understanding the sciences of his time (*341*, 75). Pixburg's 1928 work, *Novalis als Naturphilosoph* (*342*), as well as Kluckhohn's work of 1941, *Das Ideengut der deutschen Romantik* (*323*), can be seen as standing quite in the Dilthey tradition of Novalis scholarship. Both argue for the centrality of "Erlebnis" in Novalis's thought. Where Kluckhohn stops at the level of attitudes, as in stressing Novalis's "Seelisches Sicheinfühlen in die Natur" (*323*, 28) this work aims to show some of the concrete steps Novalis envisaged undertaking in his understanding of nature.

The second factor in Novalis scholarship effecting the neglect of Novalis's notion of reflectivity in the sciences arises in the works which do take Novalis's views on the sciences seriously. This was, of course, arguably the major leap in Novalis scholarship itself. The need to reinstate the value of Novalis's views on the sciences, and to show how his views were reflected in his literature, was a major task in itself. The major concern of these works lies however predominantly in analyzing aspects of Novalis's natural philosophical doctrine or in showing at a doctrinal level how Novalis's natural philosophy is linked to his literary works. There are exceptions to this, as in Neubauer's work on the influence, not just of mathematical calculus, but also of the tradition of the *ars combinatoria* on

Novalis's thought (*339*). Other works, such as those of Hamburger (*318*), Dyck (*311*) and Hansen (*319*), also treat the importance of the notion of mathematical calculus, as a method, with varying points of emphasis, for approaching Novalis's thought. Neubauer is the only critic who has extended the notion of mathematics in any depth to Novalis's literature, but, Neubauer's views (in his early works) do not, perhaps, do full justice to Novalis's philosophy. Neubauer, although he has hit upon a key link between literature and the sciences in Novalis's work, has, in most of his earlier criticism, undermined the unity of the arts and the sciences in Novalis's thought. Although Neubauer sees the relevance of mathematical calculus to Novalis's literature, the relationship is a semiotic one, and here Neubauer views literature as essentially split from reality, and as an autonomous form of knowledge. However, Neubauer has recently made significant extensions to his earlier views, as has been discussed above. This present work sides perhaps more with Uerlings than with Neubauer in seeing that the solution to Novalis's work lies to a great extent in answering questions within the framework of early Romantic utopian notions. This work, however, is chiefly concerned with the natural philosophical elements within Novalis's thought and sees them as a premise of utopian notions. Of course, key factors within such an utopian perspective, such as eschatological, and, indeed, natural philosophical ideas themselves, are cardinal to attain an understanding of the way Novalis envisaged his attempted union of the arts and the sciences. One of the best works in Novalis scholarship, Mähl's *Goldenes Zeitalter* (*331*), has treated Novalis's eschatological thoughts in great detail and will continue to be a key starting-point for any research into notions of early Romantic utopia. Given its subject material Mähl's work is also necessarily concerned to some extent with Novalis's ideas of knowledge formation. Uerlings is, too, well aware of the importance of this area of Novalis's thought, and points explicitly to the difficulties of pinning down Novalis's concept of language, and hence, of knowledge itself (*354*, 192). Of equal importance to Novalis's thought are his notions of knowledge formation in their natural philosophical context. This present work, in tackling notions of scientific reflectivity and production, and in linking these to aesthetics and a general mode of production, provides, I hope, a useful base upon which Novalis's eschatological and natural philosophical notions can be further developed and delineated.

Most of the work on Novalis's relationship to the sciences centres around the disciplines of mathematics and medicine, but there are strong arguments for approaching other disciplines, as can be seen in the importance of the geologist Werner and the physicist Ritter for Novalis. There are only two works to date which attempt in any depth to show how scientific methodology and Novalis's notion of literature meaningfully interpenetrate, and that is Schmid's work on the relationship between Novalis and Werner (*348*) and Neubauer's work on mathematics. Neubauer's work will be discussed separately below. Schmid shows how Werner's method of ordering mineralogical suites is linked to the way in which Novalis orders, "classifies" and develops types of personality in his novel, *Heinrich von Ofterdingen*. Schmid's work will also be dealt with shortly in more detail; for the moment it can be taken as an example of what Novalis scholarship has fundamentally neglected. In varying ways Novalis scholarship has omitted to analyze this interpenetration of Novalis's interests, either by discussing his natural philosophy only in terms of the sciences or specific disciplines within the sciences, or by relating scientific doctrine to literature in the terms of a mirroring of empirical knowledge, or by relating a scientific method in a not entirely appropriate manner to Novalis's literature (arguably in the case of Neubauer's semiotic use of "Combinatorik), or, indeed, by showing how in Novalis's literature a pure aestheticizing of nature takes place. No critics, apart from Schmid and Neubauer, have shown how Novalis's aesthetics are linked to a scientific method. This is because Novalis's fundamental methodological base for inquiry and knowledge formation in general has not been treated in its proper relationship to the sciences. This work, by analyzing Novalis's methodological groundwork in his notion of "experiment", arguably provides the path to treat the interpenetration of Novalis's scientific and literary interests in a broader picture of his natural philosophy than has hitherto been portrayed. Schmid, whose work does provide an instance of the interpenetration of Novalis's aesthetic and scientific interests at a methodological level, that of the relation of Werner's mineralogical method to Novalis's literary method, does not, however, feel up to explaining Novalis's notion of a "symbolische Physik", and instead pays attention to the cosmological aspects and organicism of Novalis's encyclopaedism (*348*, 77, 78 fn.1). Also Mahoney, a critic who has most substantially analyzed scientific themes in Novalis's literature, does not consider himself capable of explaining Novalis's idea of symbolic notation, even though he does discuss what he refers to as Novalis's "Praktische Physik" (scientific productivity is not explicitly mentioned by him, but it is implicit in his remarks here) (*332*, 30-37). Instead Mahoney drops the subject of scientific productivity to analyze Novalis's more purely aestheticizing of Nature in his literary works. This present work does not treat Novalis's literature for the reason that his general theory of productivity in its relationship to natural philosophy has still to be spelt out. Mahoney, for example, takes a stance often found in Novalis scholarship when he refers to the unresolvable fragmentary nature of Novalis's views on scientific methodology (*332*, 37). This view, in turn, leads a critic such as Mahoney to analyze Novalis's literary works in terms of his "naturphilosophische Spekulation", i.e. in terms of natural philosophical doctrines (*332*, 37). Mahoney treats aspects of Novalis's natural philosophical doctrine, such as a dynamic view of phenomena, and is importantly the first and only critic to link these aspects in depth to Novalis's literature, but Mahoney incorrectly views Novalis's literature in terms of the ultimate eschatological (Novalis) or mythological (Schelling) Romantic goal of man's reunification with Nature. Such a stance, which pays no respect to Romantic views on knowledge formation and productivity, inevitably concludes that Novalis's literature shows nothing but the premature and inconsequential nature of his thought ("mangelnder Folgerichtigkeit") (*332*, 76). It is somewhat unjust and even absurd to expect a Romantic such as Novalis to produce all the solutions for the presentation of some final meaning in Nature. This is, of course, not a problem of Novalis scholarship alone: literary critics in general have been rather too swift in undermining Romantic thought. Romantic irony, for example, is all too often seen as a negation of truth and as opening up paths to relativism. The issues concerning the absolute in Romantic thought have been admirably treated by Manfred Frank and aspects of his work will be outlined below. That the present work coincides with his work's concerns is seen in the way he treats the absolute not as immanent, but as transcendent. The absolute in Novalis's work can only be seen in terms of mediation, and not in terms of its outright presence. The present work's recourse to Novalis's notion of productivity releases the pressure caused by the high expectancies of critics concerned with Romanticism and opens up research to the problems of how such high ideals cannot be directly revealed, but rather transcendentally and asymptotically presented through symbols, representations, examples, cases, and methodologies in Novalis's scientific and literary writings. Thus, the notion of productivity, which accounts for the unity of aesthetic and scientific productivity, is arguably a prerequisite for the study of Novalis's literary works themselves. The notion of a general theory of productivity preempts the fact that there is link between Novalis's aesthetic and scientific views since it is concerned with the formation of knowledge necessary for both spheres of activity.

Before coming to further conclusions on the relationship between Novalis's scientific and literary thought, an overview of the works on Novalis and the sciences needs to given. This overview will be mostly chronological, but the chronology will be broken for discussion of thematic links between the works, Novalis's thought and the further outlooks on Novalis scholarship. A series of early works all importantly contributed to dismantling Novalis's excessively aesthetic image. In 1929 Richard Samuel gave substance to Novalis's scientific knowledge in his portrayal of Novalis's professional activities as a mine inspector (*344*, 1929). This work of Samuel's was then extended by Schulz in 1958 (*349*). In 1937 Wagner undertook an analysis of a broad range of Novalis's scientific interests in his notes and showed how his thoughts were in tune with contemporary scientific knowledge (*355*). In 1929 again, Käte Hamburger traced Novalis's mathematical writings in the light of Kant's epistemology and notions of mathematics (*318*). Hamburger highlighted the way Kant and Novalis viewed mathematics in the creative sense of Kant's synthetic *a priori* judgements, and how Novalis's thoughts accounted for contemporary notions of infinitesimal calculus. She further argued how Novalis went beyond Kant in his notions of space and time to arrive at a stance more comparable to the modern theory of relativity (*318*, 178). Martin Dyck's work of 1960 on mathematics (*311*) took a different but equally productive approach by treating Novalis's thoughts in a more purely mathematical sense and by linking Novalis's views in detail to contemporary debate. A recent work by Hansen analyzes Novalis's reception of contemporary mathematics in great depth. Hansen takes issue with Hamburger and denies that Novalis had a full understanding of the mathematics of his time (*319*, 490-491). Hansen sides more with Dyck, who felt that Novalis's notions of mathematics are "from the strictly mathematical point of view, unrigorous" (*319*, 491; *311*, 20). It is a pity that Hansen makes no reference to Burwick's stimulating analysis of Novalis's reception of LaGrange and Euler (amongst other thinkers of the time) in terms of his own notion of light (*306*, 120-138), for it is precisely on Novalis's ingnorance of Euler and Lagrange that Hansen bases his view that Novalis was no mathematical adept (*319*, 332-335, 393-403, 435-442, 493-496). Hansen's view here is symptomatic of his approach, because, unlike Burwick, Hansen makes little attempt to knit Novalis's thought together in terms of the possible connections made by Novalis between the various disciplines - except under the questionable overarching notion of mathematics. Hansen views continuity in Novalis's thoughts in his salient interest in mathematics and in his application of mathematical methods to notion of knowledge. Hansen also criticizes Dyck for overplaying Novalis's use of mathematics for religious ends (*319*, 491; *311*, 23). Although Dyck, as Hansen remarks, significantly refers to Novalis's use of mathematics for methodological purposes (*311*, 75, 93-94), Hansen argues that this is Novalis's main aim throughout his work:

> Es ist die Mathematik für Novalis aber primar kein Wissen ..., sondern vielmehr ein methodisches Instrument und Darstellugsmedium zur Beschreibung und Ordnung eines solchen Wissens" (*319*, 492).

The present work agrees with this view of Hansen's to some extent, but also argues for continuity in Novalis's notion of a general method of experiential knowledge and in his continuing reception and adaption of Ritter's notion of galvanism. Hansen, for example, quite misleadingly interprets Novalis's reception of Ritter, viewing Ritter's galvanic experiments in terms of a "verfehlenden wissenschaftlichen Zugriff" (*319*, 472). This view will be refuted at length in chapter four of this thesis. As far as mathematics is concerned, Hansen correctly underlines the importance of infinitesimal calculus. He points to the appeal mathematics had to Novalis for its predictiveness (*319*, 402), but gives no concrete examples of how Novalis adapted his notion of calculus to the sciences. Hansen also takes a "comfortable" positivist stance when he remarks how far Novalis was from the objective ideal of the sciences (*319*, 497) and thereby overlooks the essence of Novalis's thought which is concerned with problematizing the issues of experimental proof and practical knowledge. It will be shown how in Ritter's work the subject has to be brought into inquiry in order to enable predition (see below, p.359-360). Hansen further sees Novalis's encyclopaedic project as a "Vernetzung" of disciplines and approaches to knowledge (*319*, 420-432). The generality of the systems-theoretical sounding term "Vernetzung" does not in itself however afford the reader much light on the real priorities of Novalis's encyclopaedic project. More research is still required into Novalis's encyclopaedism so as to avoid such interpretations which tend more to relativize than to problematize or reassert Novalis's thoughts. Hansen's work, however, provides a much needed and invaluable overview of Novalis's thoughts on the sciences and offers a wealth of information in addition to that presented in the notes given by the editors of the historical-critical edition, and also in Balmes's commentary in the smaller recent edition (1978-1987) of Novalis's works (*2*).

Schmid's work of 1951 (*348*) provides valuable information on the relationship of Novalis to Werner, and gives an overview of Werner's personality, teaching methods, mineralogical and geognostical theory. Schmid points to the importance of Werner's notion of encyclopaedism to Novalis and emphasizes the fact that Novalis's own encyclopaedic project ran parallel to the lectures Werner gave on 'Enzyklopädie des Bergwerkswissenschaften' from Easter 1798 to Easter 1799 (*348*, 79). He tends, however, rather like a recent critic, Hegener (*320*), to remain too much within Novalis's own terminology to draw detailed conclusions about Novalis's encyclopaedism - a more exact analysis of *Das allgemeine Brouillon* is still required in terms of the relationship of the individual disciplines to one another, and in terms of Novalis's notion of symbolic physics. It must be assessed which substances and principles were perhaps key to Novalis's notion of a symbolic science. The assessment in this present work of Novalis's views on Ritter shows that Novalis was well versed in the area of galvanism, and although I try to treat Novalis's views on chemistry in some detail, more analysis is still required of his thoughts in this area. Schmid's work cannot however be compared to Hegener's, for the latter's circularity of argument tends to reduce Novalis's encyclopaedic project to a mere comparative project and opens up Novalis to criticism as a "playful" relativist. Hegener sees the key to Novalis's encyclopaedic thought lying in the notion of "Entwicklung" and views Novalis's project as "Entwicklung der Wissenschaften zur philosophisch-poetischen Gesamtwissenschaft" (*320*, 71). Although Hegener is here correctly stressing that Novalis's thought rests upon the notion of knowledge as a process (*320*, 70), his work is, perhaps, of questionable value for understanding how Novalis came to terms with the sciences of his time or, indeed, for explaining Novalis's thought itself, since he often analyzes Novalis's thoughts tautologically within their own thought structure and terminology. Schmid, in contrast has much to offer on the structure of Novalis's encyclopaedism, and through his work on Werner alone surpasses Hegener's interpretation of Novalis's encyclopaedism. Schmid is far more concerned to set priorities in Novalis's encyclopaedism, and views it as an enterprise which seeks to unite Werner's empirical stance with Fichte's Idealistic stance. Where Werner positions mineralogy and geognosy at the centre of his encyclopaedic classification system, Fichte provides the basis in his *Wissenschaftslehre* for putting a discipline itself at the centre, as a universal science itself, and for viewing other disciplines as its modifications (*348*, 114). Schmid states, "So spricht Novalis von einer 'doppelten Universalität jeder wahrhaften

Wissenschaft'" (*348*, 114; *N*, 3, 269), and refers to the following lines Novalis noted in *Das allgemeine Brouillon* under the heading "Enzyklopädistik": "Eine entsteht, wenn ich alle andern W[issenschaften] zur Ausbildung der Besondern benutze" (Werner's method and his employment of geognosy as the key to his system), "Die Andre, wenn ich sie zur Universalwissenschaft mache und *sie selbst unter sich* ordne - alle andre Wissenschaften als ihre Modificationen betrachte. Den Ersten Versuch der leztern Art hat Fichte mit der Phil[osophie] unternommen. Er soll in allen W[issenschaften] unternommen werden" (*N*, 3, 269). This aspect of Schmid's work has also scarcely been accounted for in Novalis scholarship, although an exception is Uerlings (*354*, 184-193).

Given the paucity of material on Werner's notion of encyclopaedism, Schmid proposes that Novalis himself may well give us the most helpful summary of Werner's thoughts here (*348*, 82). Novalis himself states:

Encyklopaedie ist, nach Werner, eine richtige Ordnung und Aufzählung der Kenntnisse, die man zu Erreichung eines *Zwecks*, nöthig hat - (eine Philosophie des Studiums -) Sie besteht aus 2 Theilen - deren Einer eine systematische *Beschreibung* der zu erlangenden Kenntnisse und Fertigkeiten - und ihrer Quellen und ihrer Folge liefert - der andre aber die Regeln des subjectiv zweckmäßigen Studiums und Exercitiums - in Beziehung auf Zeit - Ordnung und Folge der Beschäftigungen - größern oder kleinern Zweck - *Karacter des Kopfs* - *Neben und Hülfsstudien* und Übungen - begreift. Diesen nennt man Methodologie (*N*, 3, 394-395).

Here are important references to the notion of practical knowledge. The passage shows the emphasis Werner, as later Novalis, laid on scientific skills and skills in general. Unfortunately, Schmid can find no material relating to the second part of Werner's encyclopaedism, which treats the personal methodology and skills of the student and inquirer. None the less, Schmid points out that this "methodology" of Werner's encyclopaedism may perhaps be found in the work of a student of his, Franz Reuss (1761-1830), who took up Werner's ideas, for Reuss speaks of the "ganz speziellen Methode des Geognosten". Schmid comments on Reuss's notion of geognostical method:

Es ist dort von der Vergleichung der Beobachtung, ihrer Erhebung zu allgemeinen Gesetzen, erneuter Prüfung und kritischer Beurteilung usw. die Rede, von der Wechselerklärung der Wissenschaften und Hilfswissenschaften, ihrer Anwendung aufeinander und gehörigen Verbindung, der Ergänzung von Ergebnissen, die in verschiedenen Wissenschaften gewonnen sind, dauernder Überprüfung der Sätze des Systems, Selbstdenken usw. (*348*, 67-70, 84; *90*, 3, 820 ff).

Here the systematic relevance of Werner to Novalis's own views on the methodology and classification of knowledge are readily visible in the continual testing and reassessing of theory and empirical results. Scarcely touched upon by Schmid are Novalis's notion of knowledge formation and the significance of the more tacit issues of Werner's approach to inquiry, as are apparent in Novalis's comment on Werner's notion of encyclopaedic methodology. The brief analysis given in this present work goes beyond eulogistic claims about Werner's admirable personality to show more concretely what it was that drew the Romantics to Werner, and how aspects of individual and practical knowledge were relevant for theory building.[35]

As well as Schmid's portrayal of Novalis's encyclopaedism, his further achievement lies in his analysis of Novalis's literature. This is where Schmid applies scientific methodology - the practice of mineralogical classification and inquiry - to Novalis's own aesthetic method. Schmid offers an analysis of *Heinrich von Ofterdingen* in terms of what he calls "Variationen". The term sums up, in Schmid's view, the fundamental method of Werner's mineralogical classification system which employs the categories of "Gattierung, Reihung, Bildung von Verwandtschaftsystemen mit Hilfe von Abänderungen und Übergängen ... Suiten- oder Reihenbildung" (*348*, 266). Schmid views two factors as essential to Novalis's interpretation of Werner's method, that of ordering minerals in rows in general ("das Prinzip der Reihung (Variationsreihen) überhaupt"), and the notion of enhancement in the ordering of minerals ("das Prinzip der aufsteigenden Reihe, der wachsenden Vervollkommnung ihrer Individuen") (*348*, 266). Schmid argues for three main persona types in the novel, that of the poet, of the empirical scientist and of the woman (*348*, 266). How far these categories are exactly true cannot be decided here, suffice it to say that there are many interweavings of these personae, which would point to a more complex picture then he offers. The figure of Fabel in the "Märchen" stands, for example, for woman, for the creative imagination of the poet, and indeed for philosopher and scientist, since she plays a major role in controlling events in the "Märchen" and "rediscovering" or restoring the world. Even given these queries, the main gist of Schmid's work is to link mineralogical method to aesthetics. Schmid also points to the importance not only of Werner's mineralogical method, but also of aspects of his theory, i.e. his classification system, for Schmid refers to the implications in *Heinrich von Ofterdingen* of the blue rock type, "Cianit", taken from Werner's mineralogical classification. Schmid argues that this mineral class forms part of the link in the symbolism in the novel between the mineral, plant and "human" realms:

Agricola hatte schon ein Mineral Cyanus benannt; von ihm hatte es Werner übernommen und zum Gattungsnamen erhoben. So haben wir in den Namen des Ofterdingen: Heinrich - blaue Blume - Mathilde - Cyane eine Verbindung von Mineralreich - organisch - pflanzlichem und menschlichem Naturreich vor uns" (*348*, 229).

Schmid unfortunately does not analyze the further significance of the rock type within Werner's system, for it would be important to ascertain whether this rock type, employed as a key symbol in Novalis's literature, could also be used as a key symbol for mineralogy in the same way that, for example, Novalis stresses the importance of phosphorus as a major symbol and principle in chemical inquiry. Schmid's approach to Novalis's thought is an example of the type of analysis of Novalis's literature which avoids the demands that some critics place on the Idealism of the Romantics. For by studying aesthetics in terms of scientific method, and by pointing to the possibility of the way Werner's theory is interlinked with his methodology, Schmid both stresses the process of Novalis's employment of symbolism and also the richness of his symbolism. Schmid therefore brings out how Novalis was concerned with a method of attaining an ideal state or original harmony. Schmid does not explicitly make this point, since he is more concerned with the organicism of Novalis's thoughts, but his work can profitably be read in terms of Novalis's views on practical knowledge.

Other critics have been concerned with form in Novalis's works, and one of the best examples is Striedter's work, *Die Fragmente des Novalis als 'Präfigurationen' seiner Dichtung* (*353*), but none have linked a scientific way of thinking so well to his artistic method. Striedter's work, however, offers a far subtler approach to aesthetics, argumentation and form in Novalis's thought than that of Schmid. Striedter's work of 1953, like Schmid's, also suffered from not being published, but, unlike Schmid's, it was eventually published in 1985. Striedter treats Novalis's aphorisms as "Präfigurationen" of his poetic writings and thereby masterfully shows the undeniable continuity of Novalis's works. Striedter views

Novalis's fragments in terms of knowledge and poetics. Striedter shows how Novalis employs his fragments to approach the absolute of "Postulate" by the negation of purely formal knowledge or logic. The fragments are thus viewed as a type of "indirekten Steigerung" (*353*, 65) forming another type of knowing which is concerned with the processes of history and the dialectics of eschatology (*353*, 71). In his fragments as well as his poetry Striedter argues that Novalis is employing the fundamental method he learnt from Fichte, that of the "Hin und her Direktion" of inquiry, and that Novalis is continually combining or playing off these two movements of thought against one another. Striedter sees four main structures of this type of thought in Novalis's works:

> Darstellen des Gegeneinanders von Realem und Idealem in Form einer ironischen Brechung; das Produzieren eines Gesprächs, sei es in Form seiner Darstellung im Dialog, sei es in Form seiner Inzitation durch Fragmente; das Zur-Sprache-Bringen des eigenen Innern, des Gemüts, in einer Form, die selbst das Gemüt zu bewegen sucht und zu reiner Bewegung oder reiner Musikalität tendiert; und schließlich das Darstellen des Individuums und seines Weges als eines Verwandlungs- und Bildungsprozesses, als einer 'Potenzierung', in einer Form, die das Endliche zum Abbild des Unendlichen werden läßt (*353*, 123).

Striedter's analysis of the epistemology of Novalis's aesthetics, if linked up to Novalis's notions of natural philosophy, could provide a highly coherent picture of Novalis's thought. A few corrections are required however on the way he interprets the role that the absolute plays in Novalis's thought. He tends to view Novalis's own adaption of the notion of Kantian and Fichtian absolute postulates in a way that obscures Novalis's empirical and experiential interests:

> Das Vorhandensein und Wirken absoluter Postulate wird zum Hinweis auf ein inneres, von aller äußeren Erfahrung unabhängiges Vermögen des Menschen, ein Absolutes zu setzen (*353*, 81).

The implications of Striedter's statement here depend on how one wishes to interpret the meaning of the *a priori* in German Idealism. It has been argued above that the meaning of the *a priori* in German Idealism cannot unproblematically be associated with experience-free knowledge. Novalis and Schelling, as well as Kant or Fichte, stress the idea of a higher type of empiricism, although the former navigate considerably further than the latter into this area of thought, and certainly, the more one seeks to account for the role of natural philosophy and science in

Novalis's thought, the more one can see the implications of Novalis's own form of higher empiricism and the way that Novalis is essentially seeking a notion of whole experience. For Novalis and Schelling, man's inner "Vermögen", is bound up with Nature and "outside experience". With respect to the notions of autonomous or experience-free thought, Novalis does indeed allude to the musicality of human thought, but this is not an autonomous musicality, it is a musicality or "Plastisiren" that is in tune with and part of the greater musicality of the forms of Nature. The human dilemma, and its great hope, in Novalis's view, is that, although human thought is part of Nature, it is still in need of much perfection before attaining the status of the "Absolute" (*N*, 3, 123-4). None the less, the major tenor of Striedter's work lies in this direction concerning the process and historicity of knowledge. Indeed, a combination of Schmid's and Striedter's approaches to Novalis's aesthetics could lead to a reading of Novalis's *Heinrich von Ofterdingen* which would employ and seek to unite Novalis's notions of philosophy, eschatology, aesthetics and natural philosophy. Schmid's mineralogical and methodological interpretation lends a certain reality to the novel which fends off a common interpretation such as Lukács's, which condemns the novel as a mere romanticizing of the world.[36] Furthermore, it is more than probable that, if one were to combine Schmid's interpretation with further geognostical and galvanic aspects, and with the depth of Striedter's aesthetics, that one could begin to view *Heinrich von Ofterdingen* not only, as has been recently done,[37] as a response to Goethe's *Lehrjahre*, but as a work perhaps more akin, at a natural philosophical level, to Goethe's *Wahlverwandtschaften*. It is, as mentioned, Novalis's reception and adaption of Werner's form of mineralogical classification which Schmid links up to Novalis's symbolism in *Heinrich von Ofterdingen*, and no analysis is made by Schmid of the probable structural significance of Werner's geognosy in Novalis's literature. Given the broad natural philosophical implications of Werner's geognosy, which are comparable to the encompassing virtues of Ritter's notions of galvanism, it would be fruitful to analyze Novalis's employment of geognostical forces and principles to structural and symbolic ends, with the aim in mind to show how poetry and the sciences can be usefully linked.

Schmid's and Striedter's attainments and findings are of particular value when one considers that they came about before the arrival of the historical critical edition, which in itself was a milestone in Novalis scholarship. Indeed, the critical edition of Novalis, with its invaluable apparatus, for the first time fully opens up the whole field of Novalis's scientific studies and philosophical writings. Full credit must go to the editors Kluckhohn, Samuel, Mähl and Schulz.

As the critical edition arrived in the sixties and seventies, several Novalis scholars began to reassess his thought on the sciences. A considerable portion of this work has centred around Novalis's views on medicine. Neubauer's much needed and pioneering work of 1971, *Bifocal Vision. Novalis' Philosophy of Nature and Disease* (*337*), showed perceptively and in detail just how knowledgeable Novalis was of the contemporary debate on medicine, pathology and excitability theory (issues revolving around Neubauer's work are discussed in the course of this work). Schipperges argues how health and medicine play a major role in Novalis's thought. Schipperges shows how Novalis viewed medicine in a highly practical way as a "konkrete Philosophie" (*347*, 242) and as a "Konkretisierung" of knowledge (*347*, 237). Schipperges indeed places medicine at the centre of Novalis's thought as "die Elementarwissenschaft eines jeden gebildeten Menschen" (*347*, 242). Sohni's work *Die Medizin der Frühromantik* (*350*) goes into more detail than Schipperges's into the medical theory of Novalis's time. Sohni argues for Novalis's notion of therapy, and explains it as "eine freie Harmonie zwischen Körper und Seele" (*350*, 124). Sohni shows how this was realized in Novalis's notion of the interchange of asthenic and sthenic states (*350*, 124), and, in the sense of organization, man had the power to unite these forces (*350*, 124), and, further, that this power had to be trained (*350*, 129). Sohni emphasizes the broad intent of Novalis's thought and refers to his notions of medicine as "Lebenskunstlehre", that is, therapy and medicine were "arts" that involved man in his entirety, accounting for his capabilities to bring about change in the state of his whole constitution. Interestingly, Sohni views Ritter's physiological and galvanic experiments (although he does not analyze Ritter's work in any detail or elaborate on Ritter's work) as essentially carrying out Novalis's "Lebenskunstlehre", since, in Sohni's view, Ritter was searching for the "Willkühr" or organization in Nature and man (*350*, 128). Sohni is also one of the few critics who argues for the strong practice orientation of Novalis's thought, and the highly experiential nature of Novalis's view of knowledge. Sohni refers to Novalis's way of thinking in general as "ein empirisch gedachtes Realisierungsprogramm" (*350*, 190). Sohni does much to show how concretely Novalis shaped his philosophy with contemporary scientific thought, and his work is arguably the best on Novalis's views on medicine.

Since the arrival of the historical critical edition several critics have treated sciences other than medicine, such as Kapitza, Neubauer, Mahoney, Burwick and Hansen.[38] Kapitza's work, *Die frühromantische Theorie der Mischung* (*322*), explores the meaning of "Mischung" in the Romantic era. In contrast with the modern pejorative meaning of "Mischung", both in chemistry, where it denotes "einen bloß äußeren Zusammenhang verschiedener Stoffe", and in its non-scientific use as "das Sekundäre ... das weniger Originale" (*322*, 11), Kapitza shows how the term "Mischung", in the context of chemistry in the eighteenth century, had a highly defined and loaded meaning. For scientists in the eighteenth century, in the process of defining new chemical laws, viewed "Mischung" in terms of chemical affinity and physical forces (*322*, 12). Since chemistry was evolving into the most important science of matter in that period in its investigation of fundamental forces and the invisible actions within matter, the term "Mischung" acted as an exemplary and powerful tool for inquiry, and, as Kapitza shows, the term became a tool not just for scientific inquiry, but also, for thinkers such as Novalis, Schlegel and Schelling, for inquiry and philosophy in general.[39]

In his second major work, *Symbolismus und symbolische Logik* (1978), Neubauer approaches Novalis predominantly from an epistemological view-point, and, in doing so, gives his interpretation of the history of "Combinatorik". Although the work is valuable for understanding how Novalis came to terms with this part of contemporary science, Neubauer takes the view that Novalis sees language as autonomous (*339*, 163). Neubauer further views Novalis's thought in terms of a split between mind and matter, since Neubauer believes in the influence of what he refers to as Leibnitz's "radikale Trennung zwischen Geist und Materie" (*339*, 70) on Novalis. While the link to Leibnitz is useful for tracing back fundamental notions of organization such as are evident in Leibnitz's monads, it does make it difficult to explain the union of mind and matter as an organization in Novalis's philosophy. There are, however, good reasons for Neubauer's stance since Novalis cannot plainly be seen in terms of an ontological success. Neubauer reminds the critic that Novalis's stance over the attainability of the "noumena" is not so clear cut or unrelinquishingly utopian as is sometimes supposed. Neubauer's analysis of calculus and "Combinatorik" also hits upon a key part of Novalis's thought and it is his work above all that has brought these issues to light. Problematic, as will be discussed, is a stance such as Neubauer's where Novalis's calculus is understood in Kantian terms, since it is through Herder that Novalis seeks to define more closely the concept of the *a priori*. Neubauer's discussion of Novalis's literature as a calculus is, of course, central to Novalis's works, but this cannot, I think, be viewed in Neubauer's terms of autonomous language (*339*, 134-181). Instead, as has been mentioned, one should do justice to the Romantic use of the subject in their notion of language. Neubauer's work also has the ability to see Novalis in a greater perspective, for he links Novalis to the poetry of the French symbolists such as Mallarmé and their sucessors, such as Valéry, and poses questions about the nature of the autonomy of modern art (*339*, 162-181). Neubauer's recent work on Novalis, even given the great time gap since his previous work, shows that he is still reassessing and reflecting upon Novalis and, importantly, making Novalis relevant to intellectual thought today.

Mahoney's work of 1980 takes substantial steps in illuminating the way Novalis makes use of the sciences in his literature. Unlike Kapitza, who discusses the relationships of chemical and aesthetic concepts, Mahoney goes on to show just how Novalis realized his views of chemistry in his literature. Mahoney's main achievement is his delineation of Novalis's reception and adaption of Kant's views on dynamism. Mahoney argues that it is Kant's dynamism that stimulates Novalis's idea of a poetic "Auflösungsprozeß" (*332*, 29): the notion of dynamic matter, and, in particular, the fluidity of chemical "Mischungen" are seen as analogous to the fluid and creative powers of poetry (*332*, 27). Mahoney takes the reader through a series of scenes in *Die Lehrlinge zu Sais* and *Heinrich von Ofterdingen* and illuminates them in terms of dynamic chemistry and Novalis's notion of love. Mahoney's work, although not concerned with the links of scientific and aesthetic methodology, goes a long way in showing just how elements of Novalis's natural philosophy are found in his literature, and for this reason, deserves to be placed next to the works of Schmid and Neubauer. However, Mahoney's emphasis on Novalis's aestheticizing of nature ("Die Poetisierung der Natur") does Novalis less service, since, as the present work argues, there is more at stake than aethereal aesthetics and relativising irony alone.

Burwick's work (*306*) clearly reveals (as does Wetzels's essay too, 'Klingsohrs Märchen als Science Fiction' (*356*)) the significance of Ritter's notions of galvanism for Novalis, and their use in the "Märchen" in *Heinrich von Ofterdingen*. Burwick also, in a more distinct fashion than most other critics, shows with some poignant examples the complex interplay of Novalis's interests.

For Burwick underlines how Novalis uses contemporary scientific knowledge and experiments as a direct source, and applies them to his literary works. For example, Burwick explains a scene from the "Märchen" in *Heinrich von Ofterdingen*, where Novalis describes negative light, through his reading of Mrs Fulhame's essay on the effects of light on substances in the *Allgemeines Journal der Chemie* (*93*). Burwick goes on further to explain how in the "Märchen", the mind, in its imperfect perception, is compared to a *camera obscura* (*306*, 113-4). Here Burwick brings out the philosophical and practical depth of Novalis's thought. Concerning the relationship of science and literature, Burwick also makes the further point that the "Märchen" was part of Novalis's scientific programme, since literature had the role of bringing people to see science in a new magical way:

Because the *Märchen* celebrates the primal wonder, it provides the perfect setting for the reunion of science and magic (*306*, 109).

Uerlings's work of 1991 (*354*) is a major event in Novalis scholarship. It provides the most comprehensive and reflective overview of Novalis reception to date. It will undoubtedly be the standard reference work for many years to come. Furthermore, Uerlings has arrived at a highly stimulating view of Novalis's notion of knowledge which, as discussed, is of relevance to intellectual history. A key feature of Uerlings's work is his reassessment of the works of Manfred Frank, which have been greatly neglected by Novalis scholarship, and when his work has been referred to it has been misappropriated.[40] Frank's premises call into question a whole line of Novalis scholarship embodied in Haering (1954), Dick (1967), von Molnár (1970), and Neubauer (1972) (*317*; *309*; *334*; *338*). In a series of works (*312; 313; 314; 315*) Frank differentiates himself from these earlier critics in proposing the notion of the transcendent absolute in Novalis's thought, which is a thesis that stands in direct opposition to the claims of the critics above for the role of the immanent absolute in Novalis's work. Frank correctly states that Novalis does not argue for the attainment of the absolute, but that his thought is concerned with the process of approaching the absolute, and indeed in marking out empirical symbols of the absolute:

Das Ich hat nun allerdings Wissen vom Absoluten, aber nur ein "abstraktes". D.h., das reine Absolute ist dem endlichen Ich gar nicht zugänglich ...Es wird sich zeigen, daß Novalis darum im

Geiste das Moment der Zeitlichkeit, der Endlichkeit des Daseins sucht. Solange das Ich von etwas (Stoff) aus und zu etwas hin (Form) geht, ist es noch nicht das Absolute, sondern Geist, relatives Subject, empirisches Ich (*312*, 93);

Das philosophierende Ich steigt also nur bis zur negativen, abstrakten Anschauung des Absoluten. Die in den zu erklärenden Dingen vorgefundene dialektische Struktur ist nur empirisches Symbol der absoluten Einheit aller Gegensätze im absoluten Grunde, den ich bloß als heuristisches Prinzip der Philosophie gebrauchen kann, solange ich ihn nicht selber deduzieren konnte (*312*, 94).

Here, in the notion "empirical symbol", the link to this work's concern for scientific productivity can be obviously made: for in this notion lies the philosophical status of what Novalis's terms "wircksame Begriffe" or the symbols of his notion of science.

Frank's interpretation of Novalis's magical idealism shows that Novalis cannot be viewed in an idealized, aethereal, second rate mystical way, as he has been for a long time, nor can his magic idealism be seen as idealistic in an absolute sense, for his notion of magic is grounded in the need to confront the world: Novalis is concerned with "einer magischen Umschaffung der Welt" (*312*, 116). Central to Novalis's project is the role of the "Einbildungskraft", for it is there in the "intellektuale Anschauung" that the absolute is transcendent. This, as Frank points out, is also the key to Schelling's philosophy, it is thus that the absolute can be approached at all (*170*, 88).

Frank also comes close to relating scientific productivity to aesthetics when he, for example, neatly links Novalis's artistic and philosophical stances by seeing them both as part of the same knowledge process:

Kunst und Philosophie sind Ausdruck eines und desselben Erlebnisses. In beiden kommt das Universum zum Bewußtsein seiner selbst, in der Kunst durch reelle, im Denken durch ideelle Reflexion. Dem Wesen nach *ist* Kunst die Praxis der Einbildungskraft selbst, welche von der Philosophie reflektiert wird (*313*, 227).

Frank's thesis here provides the grounds for the attempt in this dissertation to find the prior basis of both art and science in Novalis's thought. While raising the above issue, Frank also points to Novalis's affinity to Goethe, for Novalis sees in

Goethe precisely the ability to employ knowledge concretely and, at the same time, the ability to reflect abstractly:

Goethe verdient größtes Lob, weil in seiner poetischen Praxis die 'genaueste Abstraction' stets mit einer gleichzeitigen 'Construction des Objectes' einhergeht, 'dem die Abstraction entspricht.' ... Mit anderen Worten, Philosoph und Poet schöpfen die Verbindlichkeit ihrer Praxis aus der konkreten (objektivierenden und abstrahierenden) Anschauung der Wirklichkeit, die sie gestalten und reflektieren (*313*, 227-228).

Novalis's comments here, as will be discussed later, refer also to Goethe's form of scientific productivity - and this again points to ways in which Frank's fundamental notions are congenial to this work's approach to Novalis. Frank's concern for the notion of time in Novalis's thought is directly echoed in this present work by its concern for practice and the process of knowledge formation. Time, process and experiential knowledge are the key to understanding Novalis's eschatology and his notion of the Golden Age since man is working towards this absolute, be it through poetry or through science. Thus it is that Frank argues that Novalis steers beyond the polarities such as mind and matter to encapsulate them in a higher pair, that of transcendence and finite time:

In dem Maße also, in dem das Absolute, Gott, über das empirische Ich hinausgehoben ist, wird dieses selbst verendlicht. Die Polarität Geist-Materie, Ich-Welt, ist einem höherem Gegensatzpaar gewichen, dem von Transzendenz und zeitlich-endlicher Wirklichkeit (*312*, 98).

Where Frank poses more strictly philosophical problems this work searches for instances in the sciences both to illustrate and to seek the origins of such problems.

Uerlings's work has in many ways begun to tackle this key aspect of Novalis's thought - transcendent temporality - in his literature.[41] In the context of Frank's work, Uerlings also raises the crucial question of Romantic pantheism. Although pantheism and transcendental immanence will be dealt with later in the sections on Plotinos, some comments are called for now. Frank shows how the notion of transcendental immanence links "Natur" and "Geist" at various levels of consciousness (*170*, 105; *354*, 162-163). The interpenetration or transreflexivity of levels of knowledge in Novalis's and Schelling's notions shows how matter, thought and purposiveness are linked in terms of knowledge formation. One could also say knowledge as a whole includes Nature, where the absolute is also transcendent. It is then not just the transcendent immanence of man's knowledge, but also the transcendent immanence of Nature's purposiveness that informs Novalis's and Schelling's notion of knowledge. One can take Frank's views further: this understanding of Novalis's pantheism as transreflexivity or interpenetration also opens up the grounds for scientific productivity. Something akin to the notion of a microcosm within man, or the Plotinian God-in-us, is expressed in Novalis's notion of pantheism. The natural inquirer is capable of finding nature within himself in the figures of the imagination which correlate at a transreflexive level to the phenomena (the "figures") of nature herself. As Novalis expresses this idea, two of the four points of transreflexivity are the outer world's own external self and the outer world within us (*N*, 3, 429). Uerlings is probably correct in pointing to the problems of Neubauer's notion of Romantic Spinozistic pantheism as absolute immanence (*354*, 136-139). None the less, Neubauer's views are important for stressing the passivity and open-ended nature of Novalis ideas. This, as has been discussed above, is significant in the light of pluralistic elements within Novalis's thought. What one sees in Novalis are aspects of Leibnitz's notion of monads, but without the radical split of mind and matter which Neubauer supposes. Novalis brings the critical philosophy of German Idealism to bear upon Leibnitz. Critical philosophy's reflective element and its use of the subject are applied to the notion of monads to steer, in turn, beyond Kant, Fichte and Leibnitz himself to refer to a reflexive, organic and purposive relationship between man and phenomena. As will be shown, however, it is to Plotinos whom Novalis essentially turns for his notion of pantheism and epistemology, as Mähl has already pioneeringly argued as early as 1963.[42]

To return to Uerlings's interpretation of Novalis's aesthetically based notion of knowledge formation, it can be seen how Uerlings's reception of Frank's notion of pantheism as immanent transcendence not only effects ideas of epistemology and ontology, but also Novalis's view of literature as well.[43] Uerlings portrays Novalis's notion of gaining knowledge as "die narrative Konstruktion immanenter Transzendenz". "Konstruktion" refers to "bewußte Setzung" and "narrative" to the fact that such constructions are only possible in terms of "Darstellung" to Novalis (*354*, 230). The relation of the present work to Uerlings's is clear: "bewußte Setzung" correlates with this dissertations's concern for the activity - understood as consciousness - of knowledge formation; "narrative" correlates closely to the present work's concern for the aesthetics of productivity. Uerlings's use of the term "immanenter Transzendenz" reveals how the relevance of his notion of Novalis's thought to intellectual history lies explicitly in the role of German Idealism. Uerlings's term "narrativ" points not only to elements of German Idealism - as mentioned above, Novalis's idea of "Darstellung" can also be seen as Idealist aesthetics- but also to the relevance of Novalis's aesthetics to current intellectual history. "Konstruktion" also arguably picks up on Uerlings's understanding of the utopian element in Novalis's work, and, in the broadest sense, implies that a progression in knowledge is possible.

Finally, it remains to be seen to what extent critics have concerned themselves with Novalis's idea of "experiment". In his work of 1970, *Krumme Regel: Novalis' "Konstruktionslehre des schaffenden Geistes" und ihre Tradition* (*316*), Gaier binds in Novalis's use of the term "experiment" within his overall interpretation of Novalis's "Konstruktion" of knowledge. Gaier emphasizes those key remarks which are, too, a major concern of this present work (*N*, 3, 123-124). Gaier interprets Novalis's "Experimentalmethode" and "Beobachtungsmethode" as the two parts of the "Hin und Her" of Novalis's construction of knowledge. Importantly, Gaier here also sees Novalis's notion of the poeticizing of knowledge in general and of the sciences, for in the two above methods of construction the inquirer moves continually between the aesthetic "Figur" and the conceptual "Wort" (*316*, 199). It is a pity that Gaier makes no detailed references to the sciences themselves - apart from some to mathematics - to further illustrate Novalis's thoughts on this matter.[44] However, one of Gaier's references, Lambert, is of particular use in defining Novalis's notion of "experiment". Gaier points out how the notion of experiment in Lambert's 1764 work, *Neues Organon* (*67*), is central to his idea of mathesis. For Lambert, as Gaier remarks, the construction of "Wissenschaft und Leben allgemein" are viewed as an experiment (*316*, 183). Lambert's significance for Novalis would appear to reach beyond the idea of "Konstruktion", however useful this term is for explaining Lambert's and Novalis's view of mathematical construction in calculus. It is particuarly the manner in which Lambert treats knowledge in a critical and experimental way that would have attracted Novalis.[45] One of the first lines Novalis jots down from Lambert runs:

Lehrsätze und ErfahrungsSätze lassen sich in einander verwandeln, wenn man zu leztern den *Beweis* sucht und Erstere auf die *Probe* stellt (*N*, 3, 130; *67*, 1, § 148).

This type of questioning, that can be seen as an "ordo inversus" of primary statements and principles, has great affinities with Novalis's spirit of inquiry. Here statements are relativized (i.e. in the sense of "aufgehoben") and referred to other ones transreflexively in order to be put to the test.[46]

Löffler is another critic who discusses the importance of experiment to Novalis - this time with the emphasis on Fichte - in a brief but perceptive forray in 1978 in his essay, 'Berufserfahrung und Theoriebildung bei Friedrich von Hardenberg (Novalis)' (*326*). Löffler argues that it is through Fichte that Novalis comes to find the central importance of "experiment" to his own thought. Löffler argues it is Novalis's understanding of "experiment", as espoused in the tenets of Fichte's practical philosophy, that allows the inquirer to arrive at genuine experience:

Nur im Experiment entsteht "echte Erfahrung", d.h. eine vom Willen des Menschen diktierte Realität. Allein im Experiment öffnet sich der Weg zur realen, praktischen Tathandlung, in der das Ich das Nicht-Ich setzt. Es ist im Sinne Fichtes eine wissenschaftlich begründete Handlung. Zugleich ist es auch eine in der Praxis erprobte Methode, neue Realität zu schaffen.(*326*, 54; *N*, 3, 391).

Löffler further argues that Novalis takes on Fichte's dialetic method as an empirical-experimental method (*326*, 55; *N*, 3, 391). Whether Löffler's interpretation is to be understood as Marxist is not important: dialectics are undeniably present in Novalis's interpretation of Fichte. Equally present in Novalis's method, which Löffler does not point out, is the notion of a "phenomenal" calculus and the notion of the row. In the introduction ample room has been given to the discussion of the "row" or "series" in early Romantic natural philosophy. In Goethe, Novalis and Ritter one finds, in fact, a blend of dialectics, calculus and ideal empiricism, for out of the row of phenomena or experiments there rises a synthesis or "higher experience" as Goethe puts it. The "Formel" of the row is at the same time synthesis, enhancement, function and "higher experience" (see also below, chapter two, sections 1.4 and 1.8).

A further point Löffler makes concerns the ethics of inquiry. Löffler sees in Novalis's notion of "experiment" an attempt to do justice to nature. For by respecting not only the inquirer's subjectivity, but also the subjectivity of nature in her purposiveness, Novalis, like other Romantic natural philosophers, pays respect to nature:

Es gibt noch einen zweiten Grund, weshalb gerade das Experiment im Zentrum der Hardenbergschen Philosophie steht. Im Experiment glaubte Hardenberg jene Form der Veränderung der natürlichen (und gesellschaftlichen) Umwelt gefunden zu haben, die der eigenen, inneren Gesetzlichkeit der Natur am ehesten gerecht wird. Die Anerkennung der Natur als einer eigenständigen in sich organisierten Welt bedingt eine vom Menschen unterschiedene Gesetzmäßigkeit, die respektiert werden muß (*326*, *57*).

One can extrapolate these thoughts of Löffler to argue that the early Romantic notions of "higher" empiricism and the whole of experience, as espoused in its attempt to remain close to the phenomena under investigation, and in its interest in productivity, experiential knowledge and purposiveness, have definite ethical elements.

As a conclusion to Gaier's and Löffler's work[47] on "experiment" one can observe that Lambert's and Fichte's generally philosophical approach to "experiment" are complemented by further thinkers who influenced Novalis. Lambert and Fichte is thus two of the many sources Novalis draws upon in his search for a reliable method. The introduction has shown the relevance of Werner, Goethe and Schelling to Novalis's notions of natural philosophy, productivity and "experiment". Chapter Two recapitulates these sources and others, who all deal with the philosophy of "experiment" with differing emphases, and shows in more detail the context of Novalis's thought here.

*7. Plan of the work.*

The major themes and patterns of thought approached in this dissertation, the issues of practice, have been prefigured in the introduction. In the following chapters, early Romantic notions of practice and the productivity of knowledge are illustrated in Novalis's scientific and philosophical writings. The dissertation attempts to show how Novalis was a great early Romantic methodologist of practice, on par with Goethe and Schelling at this level of knowledge.

Chapter one positions Novalis's notion of "experiment" within the tradition of the theory of experiment. The chapter starts with a brief account of the swing in natural philosophy towards experience. I then go on to consider epistemological and methodological issues surrounding the term *experimentum crucis*, and how this term was employed by Newton. The final section of the chapter explores the key part of Novalis's notion of "experiment", its aesthetics. Certain parallels are drawn between Novalis's idea of concrete, experiential thought and the type of knowledge espoused in the tradition of memory systems. This leads to one of the chief characteristics of Novalis's notion and rhetoric of "experiment", namely the re-experiencing of experience in the imagination. I then move on to conclude with remarks on the encompassing nature of Novalis's idea of "experiment", and give examples to show how this is part of a fundamental attitude of his, as expressed in his idea of "Experimentalphilosophie".

Chapter two considers the breadth of intellectual thought channelled into Novalis's idea of "experiment". It is discussed how, for a variety of reasons - ontological, methodological and natural philosophical -, that Novalis's reception of Plotinos is a major point of reflection in his life, and, consequently, for his notion of "experiment". Other major players considered who take up a central role in Novalis's thought are Werner, Herder, Goethe and Fichte.

Chapters three and four step out of the immanent discussion of Novalis's thought in terms of the thinkers of his time to reflect over key patterns and strategies in his notion of knowledge. I explore two central strands of his thought: the first lies in his desire to unify theory by means of a classification system of knowledge; the second lies in his arguably more attainable aim of unifying practice. Novalis's wish to classify the sciences can be sketched briefly as a project setting out to provide a system of symbols in the sciences for further employment in inquiry. The unification of practice is, arguably, an epistemologically more complex affair, but, I maintain, more realizable. In this programme for inquiry, Novalis seeks the unification of practical theory with methodology, and - as illustrated by Ritter's work - the individual inquirer has a central role to play in this programme. Both programmes put forward proposals, to varying degrees, for the attainment of consensuality and consensus in inquiry. It is Ritter's form of individual natural philosophical productivity that provides an instance of the probability of the more powerful form of consensuality that Novalis intimates in his writings. In the course of these reflections, a detailed path is taken back into the sciences of the time, into the pneumatics debate, and into Ritter's work on galvanism. Further examples, too, of Novalis's reflection over the sciences of his time are given.

Chapter three considers Novalis's view of paradigmatic symbols for inquiry in the light of the pneumatics debate and Novalis's own speculations on "Physik". Novalis's understanding of phosphorus as a paradigmatic symbol is analyzed in detail.

Chapter four explores the immense variety of ways in which Ritter's thought and work connects with Novalis's own thought. Here, Novalis's idea of "experiment" is realized in Ritter's methodology. Ritter's work finely illustrates a breadth of issues concerning the use of aesthetics in inquiry. Practical knowledge, aesthetics, and case studies all form a coherent whole in Ritter's work, and, also, in the manner in which Novalis interprets Ritter.

In the conclusion, the concerns of this dissertation are subjected to further reflexive assessment. Possible values of this dissertation for intellectual history as a whole, with respect to the history and philosophy of science, and with respect to the realm of studies carved out under the title of literature and science, will be put under examination. In this manner, an attempt will be made to put the notion of unifying practice into an appropriate perspective. Initially, questions involving the practicability of the early Romantic notion of inquiry will be raised. I will then move on tentatively to propose possible spheres - primarily within the realm of the history of the practice of ideas - where literature and science studies could, perhaps, be enhanced.

Chapter One

# Novalis and the tradition of "experiment"

1. *Experiential contra* a priori *knowledge.*
2. *The role of the* experimentum crucis *in natural philosophy.*
3. *"Experiment" as aesthetic and natural philosophical productivity.*

*1. Experiential contra* a priori *knowledge.*

As mentioned in the introduction, a study of the work recorded for late 1798 and early 1799 in the *Freiberger naturwissenschaftliche Studien* and *Das allgemeine Brouillon* affords the reader an insight into Novalis's interests after his arrival at the Freiberger Bergakademie. Most importantly, one should not be misled by the variety of subjects, disciplines and thoughts that Novalis attempts to combine and unite in his encylopaedic project, and then assume that his undertaking had no real base, and that he was merely forcing notions together in conceptual play. For behind his apparently idealistic and difficult remarks lies a decidedly empirical orientation and a wish to test and clarify knowledge. The more purely conceptual interests of the *Fichte Studien* are replaced by a genuine attempt to encounter the outside world through a philosophy that seeks to blend the sophistication of German Idealism in Kantian and Fichtian epistemology, and the Neoplatonic tradition, with contemporary scientific thought; and, further, to analyze and theorize about inquiry itself in a highly historical sense. Both *Die Christenheit oder Europa* and the *Hymnen an die Nacht* illuminate Novalis's highly historical attitude to knowledge. One can say that, as in his eschatological work he views religion as a movement and continuum of thought throughout the ages which culminates in a vision of how man, at the end of the eighteenth century, should act and practice, continuing a quest conducted throughout the ages, so, too, in *Das allgemeine Brouillon*, Novalis puts forward a programme for knowledge that takes account of the development of knowledge and places man within this process. The history of science or discoveries is never, to Novalis, a plain accumulation of facts, but rather a whole process of the very acts of discovering and the procedures used. In this philosophy, Novalis's concept of "experiment" plays a key role. His use of it implies that he did see the advancement of knowledge in terms of the empirical tradition. Knowledge for researchers in the late eighteenth century was, in general, bound up with the great development of the sciences, yet Novalis's understanding of "experiment" is broader than that met in traditional natural philosophy, and includes more than strict and quantitative science alone. Moreover, Novalis's attitude to "experiment" is quite different from today's belief that to "experiment" is to put a theory to the test, which was a view often held in the eighteenth century too. In fact, Novalis attempts a thorough re-evaluation of the meaning of "experiment".

Particularly since Francis Bacon's (1561-1626) works, "experiment" had meant a dismissal of scholastic argumentation and a return to experience itself as the source for knowledge. It goes without saying that the concept of "Experimental philosophy", based on Bacon and which so imbued the attitudes of the Royal Society and Newton's works, was a radical turn around in thought. Its enormous significance for the development of science in particular and for society in general is well documented. After Bacon, a major new development of ideas on experiment came, of course, with Newton. Newton's science created a shift away from *a priori* principles to what has been referred to by Lakatos as the less strict "psychologism" of induction.[1] Lakatos's interpretation brings out Newton's empirical stance to knowledge and its fundamental opposition to the formalism of the Cartesians. As Lakatos says, Newtonianism struggled against the restrictions of the essentialist, *a priori* metaphysics of the Cartesians, which was, as Newton exclaims, making him a "slave to defend" his theories (*76*):

> This is why they [*the Newtonians*] were forced, almost against their will to oppose the tyranny of self-evident, *a priori* first principles and thus to change the standards of scientific proof and criticism and indeed, the very concept of knowledge (*227*, 207).

Lakatos explains just how Newton's form of empiricism set out a quite different agenda of what counted as valid science, by holding up a strong belief in the faculties of the scientist. In this sense it is justificationist or dogmatic;[2] it argues against infallible *a priori* metaphysics:

> The inherent psychologism of Newton's concept of experimental proof puts him into the category of justificationist fallibilism: Newtonian standards are those of justificationist fallibilism. They are not third-world standards but psychologistic standards. The proof of the phenomena is guaranteed by the "lack of speculative basis", "carefulness", and "experimental skill"; the proof of the inductive generalization is guaranteed by the "caution" and "sagacity" of the theoretician: one could well call them "proofs by pedigree". Kepler's laws were proved by Kepler's "reliability" as an observer; Newton's laws by Newton's "sagacity" at making inductive inferences (*227*, 209).

Thus Newton's inclusion of the famous Rule IV in the second edition of his *Principia* in effect, as Lakatos observes, through its demand that metaphysical criticism should not force the inquirer to reject inductive proofs, "amounts to a truncation of the Cartesian model of explanation" (*227*, 205). Science could now, in Newton's view, concentrate on the region below first principles. It may not be possible to deduce the causes of phenomena from the first principles at the top of the Cartesian model, but the lower regions may yet be scientific, and could extend man's knowledge within what was now an open-ended model of scientific knowledge (*227*, 205).

Newton's particular form of induction is made apparent in his desire for proven propositions, but the proofs he was seeking in his experimental philosophy were patently different from those of the Cartesians. Newton was aware of this, and this in turn explains his ambivalent stance to proof, as Lakatos argues, because Newton wished to establish his own "psychologistic" standards of proof (*227*, 209). Thus he could say, as Lakatos points out (*227*, 208), that "arguing from Experiments and Observations by Induction be no Demonstration of general Conclusions" (*74*, 404) although experimental-inductive proof "is the highest evidence that a Proposition can have in [my] philosophy" (*77*, 155).

This Newtonian position also seems to represent one of the pillars of Novalis's method. It is expressed in the remark (above, p.18), concerning the limitations of logic: when logic is used, it should not be used alone; beyond analytical-logical proof, one also needs experimental proof ("daß wir mit der Logik *allein* nicht viel ausrichten könnten ..." (*N*, 3, 402)). Novalis thus suggests a method that should combine logic with those faculties that fall into the realm of psychology. Both tools are limited on their own, and only prove fruitful together ("daß wir noch ein andres Vermögen und seine Theorie aufsuchen müßten, die als dem Denkvermögen und d[er] Logik entgegengesezt und *allein* eben so nutzlos, als diese, in Verbindung mit diesen gesezt werden müßten, um daraus ein zusammengeseztes Vermögen - und zusammengesezte, sich gegenseitig complettirende Theorieen und Handl[ungen] und Resultate zu erlangen und so fort"). Importantly, both aspects consist of, and have to be proven through, "experimentation" ("*Am Ende* scheint alles Nachdenken auf ächtes Experimentiren zu führen - und die sog[enannte] Vernunftlehre - die Nothwendigkeit, Methode, etc. des Experimentirens und Lebens, als eines beständigen Experimentirens zu enthalten und beweisen" (*N*, 3, 402)). The ultimate arbiter here appears to be a form of experimentation, which subsumes both logic, other faculties, and practical experiments, in a higher order experimental method. Clearly Novalis's own notion of induction opposes dogmatic *a priori* metaphysics. In arguing for experiential knowledge, his view is bound up with the empirical tradition in the history of the sciences. Yet at the same time, by connecting "Experimentiren" and "Leben", he goes far beyond the framework of empirical science and returns to the earlier notion of "experiment" as "experience"; in so doing, he enters the debate on the issues of individual and practical knowledge involved in processes of knowledge formation.

The metaphysical concepts Novalis wishes for in inquiry should firstly be few, and secondly be experiential or concrete, as opposed to *a priori* analytical concepts, as a remark of his in 1799 shows:

> Allgemeine Behauptungen gelten in der Naturlehre nicht. Ihr Vortrag muß *practisch, technisch, real* seyn ... Unsre Physik spricht nur von den allgemeinen Elementen der Natur - von den allgemeinen *wircksamen Begriffen* - oder den Naturkräfte[n] ... Alles ist beschränkt, auch des Menschen Wissenschaft soll nach Zeit, und Ort etc. bestimmt seyn ... (*N*, 3, 600).

Part of the necessary limitations on inquiry are found, in Novalis's view, in the inquirer's own physical and mental limitations. What Novalis grants the status of "wircksame Begriffe" will be discussed in the following chapters, particularly where the sciences are treated in detail. Here it is necessary to note that Novalis's fundamental opposition to dogma or *a priori* systems explains his recourse to the notion of "experiment", and his use of "experimental" proof in his notion of induction.

2. *The role of the* experimentum crucis *in natural philosophy.*

A key methodological instance in the history of science, Newton's use of the term *experimentum crucis*, further appropriately illustrates the development of the notion of induction and the switch to experience and to experiments in the sciences. The concept makes clear the complexities of the issues Novalis was dealing with. For however much of a paradigm for hypothetico-deductivism Newton's *experimentum crucis* later came to be, and this is a key reason, for example, why Goethe polemicizes so much against him, Newton's own method itself was fundamentally empirical-inductive. Confusion often arises over the role of experimentation after a theory has gone down in history as being the correct one, as Laymon argues, for at this stage an "experiment" such as Newton's is described as if all other theories were quite wrong, and in the description of the experiment the original inductive procedures are omitted. Indeed, from the perspective of a thinker such as Novalis, the whole notion of a continuum of inquiry is overlooked:

> Once a competition between theories has been decided (for whatever reasons) and a winner chosen, the history of this competition very often is restricted to only the early stages of explicit deduction where very idealized experimental descriptions are used. Ordered pairs of initial conditions and predictions are selected so as to make it appear that the rejected theories were refuted by a simple incompatibility with the facts (*234*, 76).

As Sepper has shown so clearly for the situation that Goethe (and Novalis) lived in, Newton's views were in fact simplified so much as to be presented in a meaningless and fallacious way in eighteenth century textbooks (*276*, 27-38). This is indeed a natural retrospective reaction to knowledge and discoveries: the actual process of discovery is forgotten, since the new theory has now become embedded in the minds of scientists as the "facts" themselves. Yet from Novalis's perspective of "zusammengesezte, sich gegenseitig complettirende Theorieen" (*N*, 3, 402) this whole tendency would seem to represent an impoverishment of science in particular and of "Leben" in general.

One may, perhaps, say that in his optical writings Newton was really trying to espouse the old Aristotelian ideal of methodology, directly constructing theory through sensual impressions. As Nickles remarks, in Newton's *Opticks*, his theories on the nature of light are conveyed as "deductions from the phenomena" (248, 314), for Newton was keen to present his theories without having to go into purely formal reasoning. Sepper, too, comments upon this aspect of Newton's thought when discussing Newton's optical works:

> Despite the brilliance of Newton's optics, then, despite the apparently immediate self-evidence of his experimental theory, one might reasonably wonder whether it would not have been better had he, like Goethe, come to realize and admit the problematic nature of experimental proof rather than conceal and ossify it ever more completely with masses of experiments, improperly qualified claims, and a veneer of mathematics. For in Newton's case we are talking about a scientific success that decisively influenced the natural sciences for generations. Insofar as these shortcomings and this dogmatism went unnoticed and uncriticized, we have to deal with a significant failure of early modern science itself (*276*, 142).

Even excepting such methodological shortcomings, it is well known that Newton certainly cannot be labeled in straightforward positivist terms. As well as Koyré himself, post-Koyréan intellectualist approaches to Newton, as in the works of Dobbs (*163*), Heimann and McGuire (*192*), Rattansi (*240*), McMullin (*241*) and Kubrin (*222*), have shown the links of Neoplatonism, alchemy, religion and philosophy to Newton's natural philosophy. Heimann and McGuire have argued, for example, that in the Newtonian notion of force and Locke's notion of power common themes can be found "which were fundamental to the problems of scientific explanation" (*192*, 305). The sociological influences on, and effects of, Newton's thought have also been traced. Manuel, as well as pointing to the effects of religion on Newton's thought has also shown how Newton manipulated people and institutions to forward his natural philosophy (*239*, 264-291). Margaret and James Jacob have written on the social uses of Newtonian natural philosophy during Civil War, Interregnum and Restoration (*205; 204*). Indeed, historians have shown that there were a variety of types of Newtonianism - ranging from pantheistic materialism (*206*, 552) to transcendent Newtonianism (*293*).

Of particular interest here in Newtonian historiography are not so much questions concerning religion or cosmologies as the ones concerning experimental method, and are treated in Sepper's work, and also in Schaffer's account of the role of the *experimentum crucis* in Newtonianism. When discussing the term *experimentum crucis* in Newton's natural philosophy, Schaffer refers to the problem of the

"Experimenter's Regress" (*270*, 68-71), a notion elaborated on by Collins (*155*, 79-100, 129-30). The term "Experimenter's Regress" refers to the difficulty of justifying an experimental method and the essential circularity of the relationship between practice and theory. Collins describes the problem thus: to settle a theoretical question over phenomena, "experimenters needed to know whether or not" the subject of their inquiry existed, "and to find this out they needed to do some well-performed experiments. But to know whether their experiments were well performed they needed to see if their experiments produced the 'correct' results, and to determine this they needed to know whether" the subject of their inquiry "existed - and so on. This is the Experimenter's Regress" (*156*, 88). Schaffer views some solution to the "Experimenter's Regress" in Newton's *experimentum crucis* in the role instruments played in consensus over Newton's optical theory. It was the "superior quality" of the English prism that played a major role in consensus (*270*, 94). Taking a different line, Cantor raises the question of rhetoric surrounding the term *experimentum crucis*. Cantor points to how "philosophers of science now generally downplay the significance of" crucial experiments, "partly because they fail to recognize them as rhetorical, dramatic devices" (*150*, 176). Novalis's notion of experiment refers to another aspect commonly overlooked by philosophers of science, for he is not essentially concerned with the rhetorical appeal of experiments, but with the essential role of experiment in knowledge formation, and with the need for a tight link between experience and theory. If one wished to interpret Novalis's view of "experiment" in terms of rhetoric, then it cannot be in the plain sense of "argumentative value", whether linguistic or visual; instead, the interpretation should be undertaken in the broader terms of aesthetics and the practical appraisal of knowledge. As argued in the introduction, the early Romantics emphasize the notion of experience to argue for the phenomenal, the natural and the practical aspects of knowledge. The role of experiment in early Romantic styles of inquiry is part of a total approach to inquiry. Novalis's stance here can be seen as a point of reflection on the nature of experiment, positioned between its Baconian meaning as "crucial instances", the Newtonian notion of *experimentum crucis*, and, for example, the abundant use of the term *experimentum crucis* "during the optical revolution of the early nineteenth century" (*150*, 176).

Novalis's notion of experiment is bound up with the themes revolving around the Baconian notion of induction. An overview of the context of Bacon's and Newton's thoughts will elucidate this. Newton himself saw his *experimentum crucis* as being firmly placed in the Baconianism of the Royal Society, and the history of the notion *experimentum crucis* readily supports this. However, as much Newton may have wished to give the impression that his theories themselves were the correct ones, and this was in fact how they also came to be understood later, namely as examples of hypothetico-deductivism, i.e. his "experiment" was proof of his theory, his own actual method reveals that his *experimentum crucis* was the outcome of careful empirical work, a gradual process of selection that did not merely directly induce or "deduce" from the phenomena. His actual working-method cannot be unequivocally identified with his concepts of scientific method. Newton's adoption of the term *experimentum crucis* is part method, part strategy. Koyré and Lohne have pointed out how Newton's use of this term arose from his reading of Hooke, who actually coined it (*220*, 42; *236*, 173-4, 179).[3] Hooke first used it in his *Micrographia* referring to what "our thrice excellent Verulam calls *Experimentum Crucis*" (*53*, 54).[4] However, Hooke actually arrived at the term by confusing Bacon's "Experimenta Lucifera" with his "Instantiae Crucis". From the start, therefore, the concept has the status of a phantom, attached to Bacon's name in order to lend authority to an argument. Newton himself echoes the original meaning of the term "Experimenta Lucifera" when remarks on "ye most luciferous & many times luciferous experiments too in Philosophy" (*75*, 1, 10). But the source in Bacon is slightly different. In his *Novum Organum*, Bacon demands inquirers "to judge about natural causes by means of crucial instances and luciferous experiments and not solely by probable reasons" (*7*, xxxvi). Subsequently, the epithets became transposed, and the new second term began its independent existence. Lohne gives two quotations from Bacon which show what he meant by crucial instances:

For instance, if we are inquiring into the nature of Colours, prisms, crystals, which show colours not only in themselves but externally on a wall, dew, etc., are Solitary instances ... From which we easily gather that colour is nothing more than a modification of the image of light received upon the object, resulting ... from different degrees of incidence (*7*, XXII);
When in the investigation of any nature the understanding is so balanced as to be uncertain to which of two or more natures the cause of the nature in question should be assigned, on account of the frequent and ordinary concurrence of many natures, instances of the Fingerpost (*Instantiae Crucis*) show the union of one of these natures with the nature in question to be sure and indissoluble, of the other to be varied and separable; and thus the question is decided, and the former nature is admitted

as the cause, while the latter is dismissed and rejected. Such instances afford very great light, and are of high authority, the course of interpretation sometimes ending in them and being completed (*7*, XXXVI).

Bacon's "instances of the Fingerpost" were thus particular cases which decided between one theory and another; the image of sign-posts at a crossroads seems to have suggested to Bacon the word "crux" (*236*, 174). His idea is crucial to modern methodology. For here, theory is to be decided upon through a particular instance of experience and not by strict argumentation at a theoretical level. This was the method which was passed on to Newton, and which Novalis draws on to form part of his notion of experiential knowledge, and part of what he calls "Experimentalphilosophie" or "thätiger Empirismus". Sepper points to a further aspect of the *experimentum crucis*: the fact that the it was perhaps even more concerned with refutation than with experimental confirmation. The *experimentum crucis* can be used to leave theory open for further inquiry:

By its nature an *experimentum crucis* is meant to perform two functions: It should place the experimenter at the intersection of two or more possible ways of accounting for phenomena, and it should exclude some of the possibilities from further consideration while perhaps also pointing to one or more alternatives as the most promising paths. An experiment that fulfills this office must be designed so that it yields unequivocal information. Even if it does not clearly identify a single path, it must at least point away from one or several alternatives. The nature of the *experimentum crucis*, then, is to refute, even more than it is to confirm (*276*, 134).

Sepper's reading of the *experimentum crucis*, as he argues himself, applies to Goethe's notion of experiment. For in his own work on optics, Goethe was concerned with the "many-sidedness" of light and not its mathematization in the Newtonian sense (*276*, 156). Goethe was concerned with keeping inquiry open and exhausting as many aspects of the phenomena of light as possible as opposed to reducing light to Newton's "mathematicophysical certainty" (*276*, 141). Where Newton sees light in terms of his mathematical concept of the ray, Goethe wished to view light in a far more comprehensive way, interpreting light, for example in terms of a phenomenon with chemical and physical qualities, and also in terms of physiology and aesthetics. By virtue of his encompassing attitude to light theory, Goethe is clearly more concerned with refutation in experimentation and seeking further approaches to the study of light, whereas Newton can be viewed as being keen to close the debate on optics as soon as possible, i.e. primarily to confirm his theory through experimentation (*276*, 134-156). This aspect of the *experimentum crucis* involving refutation also corresponds with Novalis's emphasis on the need to seek a reliable method of inquiry, which is arguably the key concern of his natural philosophical writings.

Putting Newton's particular stance to the *experimentum crucis* aside, it can be seen that Novalis dwells upon the Baconian meaning of experiment as a fundamental recall to experience. The Baconian sense of experiment, and the subsequent swing in the sciences towards experimental proof, provides a key starting-point for Novalis's wider view that all knowledge was itself experience and that any valid knowledge had to be experiential or concrete itself.

*3. "Experiment" as aesthetic and natural philosophical productivity.*

Although Novalis may often be appearing to use the term experiment in the sense of a test, and naturally his interests do lie in inquiring into Nature,[5] his meaning of the term is not strictly in accordance with the Baconian rigorous interrogation of nature. Whilst advocating the intervention of experimentation, as will be shown in the coming chapters, his attitude entailed that Nature should be allowed to speak herself. By "experiment" he tends to mean an "experiential activity" and not so much a forcing of Nature to speak; his idea of a scientist as a person who has "Gefühl" (*N*, 3, 179) lies far closer, for example, to a figure such as Goethe's Faust, a figure of the magus tradition deeply at one with Nature, and who disdains knowledge gained by "torturing" Nature ("Und was sie [*Nature*] deinem Geist nicht offenbaren mag, / Das zwingst du ihr nicht ab mit Hebeln und mit Schrauben" (*38*, 3, 28)).

Within experiential activity, Novalis naturally envisaged a direct confrontation with Nature in laboratory experimentation, but also, as a necessary part of inquiry and "experiment", and bound up in the "direct" confrontation, he envisaged what can be called an "indirect" confrontation with Nature. In the indirect confrontation Novalis demands that the scientist should sharpen his mental tools, and approach inquiry with his own "Gefühl" for Nature. As mentioned, Simon Schaffer underlines precisely this part of Novalis's attitude to scientific inquiry, when speaking of Novalis's meaning of "Genie" in relation to the era (*271*, 91). "Genie" is another term used by Novalis, and is comparable to "Gefühl". In approaching inquiry with "Genie" or "Gefühl", the scientist approaches Nature with both analytical and empathetic skills: clearly, for Novalis, "experimentation" with Nature is more than a "test". The experimenter has above all to have a genuine feel for, and experience of, Nature ("Der ächte Experimentator muß ein *dunkles Gefühl der Natur* in sich haben ... Die Natur *inspirirt* gleichsam den ächten Liebhaber und offenbart sich um so vollkommner durch ihn - je harmonischer seine *Constitution* mit ihr ist" (*N*, 3, 256)). Importantly, this closer knowledge or commune with Nature allows, in Novalis's view, a greater precision in dealing with natural phenomena: it enables the performance of a more comprehensive experimental method ("vervielfältigen ... vereinfachen ... combiniren"). The closer experience of natural phenomena also assists in the presentation and explanation of Nature. It helps to order experimental observation ("Auswahl und Anordung"), and allows for a broader and more versatile presentation of Nature ("artistische, sowohl zusammengefaßte, als ausführliche Beschreibung") (*N*, 3, 256). As already discussed, Goethe and Ritter were exemplary for this experimental approach for Novalis, both in their experimental method and in their presentation of their findings.

Thus, too, when in the following remark Novalis refers to the Baconian method, he emphasizes how the knowledge gaining process in experimentation has to pass through man's "Organ", i.e. man's critical and moral tools:

*Die vollendete Speculation führt zur Natur zurück.*
Das ganze Geheimniß des Philosophirens liegt in der generalisirten Baconischen Sentenz - Philos[ophia] *abducit et reducit* - die Abduktion ist der Reduktion wegen. Die Natur ist aber weit mehr, wenn sie durch das Phil[osophische] Organ gegangen ist (*N*, 3, 402).

Although Novalis is clearly asserting the importance of the Baconian return to experience, and a careful process of inductive exclusion and rejection, he is, at the same time, underlining how the very process of gaining knowledge in experimentation is itself "experimental". As Novalis then continues, since, in his view knowledge is a phenomenon itself, it also has to be treated as any other phenomenon in Nature, and has to undergo experimentation:

Philosophism ist ein höheres Analogon des Organism. Der Organ[ism] wird durch den Philosophism complettirt und umg[ekehrt] (*N*, 3, 402).

As the term "Organism" implies, the process of gaining knowledge is itself part of the greater organism of Nature; philosophy is an analogical entity of the natural world itself, and as such Nature can be "completed" by philosophy, and, vice-versa, philosophy by Nature. Moreover, philosophy aims not just to test Nature, but also to test itself, and also, as the remark on "Genie" shows, philosophy was not only to test, but also to conduct inquiry into Nature with a feeling and understanding for her.

The following remark made by Novalis on Fichte's method of philosophy further reveals how Novalis held the process of gaining knowledge to be an essential part of a broader view of experimentation. Indeed, Fichte's notion of experimentation in the working method of his philosophy is, along with the Baconian notion of experimentation, another key starting-point for Novalis's concept of inquiry. Novalis's following remark on Fichte's working method shows how, since knowledge is part of experience itself, it has to be permanently tested in a process that mediates between making statements on Nature and the phenomena themselves. Again, the very experiential nature of gaining knowledge itself is brought to the forefront:

Alles kann zum Experiment - alles zum *Organ* werden. Ächte Erfahrung entsteht aus ächten Experimenten. (*Versuche* sind Experimente.) Fichte lehrt das Geheimniß des Experimentirens - er lehrt Thatsachen und Thathandlungen, oder wirckliche Sachen und Handl[ungen] - in Experimente und Begriffe verwandlen. Sachen in entgegenges[etzte] Handl[ungen], in Begriffe - Handl[ungen] in entg[egengesetzte] Sachen - auch in Begriffe. Diese Begriffe hängen zusammen - die Handl[ungen] und Sachen hängen zusammen - und alle 4 hängen gleichzeitig zusammen (*N*, 3, 391).

The highly psychological Fichtian approach to arguing with and working with concepts appealed to Novalis for its highlighting of the activity ("Handlung") of the knowledge gaining process. A genuine experiential approach to knowledge, as Novalis perceived in Fichte's method, provides a fuller and more comprehensive account of the matter under investigation ("Ächte Erfahrung entsteht aus ächten Experimenten"). Here also, in Novalis's account of the Fichtian philosophical method, the "test" is not only carried out on external phenomena, but on knowledge itself, knowledge as an activity tested; this allows for greater methodological complexity: concepts for processes and objects, and the processes and objects themselves, are all viewed in their interaction with one another ("alle 4 hängen gleichzeitig zusammen").

It should be made clear that Fichte himself does not concern himself with the sciences, and intentionally remained in the realm of the philosophy. This explains those remarks of Novalis's where he distances himself from Fichte, for Novalis was seeking a less strictly philosophical methodology that would cover his scientific-empirical interests as well. Yet, none the less, in the following remark of Fichte's in his *Wissenschaftslehre*, his view of "experiment" and his dismissal of formal thought (which he likens to "ein todter Begriff") is, clearly, in its rudiments, similar to Novalis's stance to knowledge:

Ganz anders verhält es sich mit der WissenschaftsLehre. Dasjenige, was sie zum Gegenstande ihres Denkens macht, ist nicht ein todter Begriff, der sich gegen ihre Untersuchung nur leidend verhalte, und aus welchem sie erst durch ihr Denken etwas mache, sondern es ist ein Lebendiges und Thätiges, das aus sich selbst und durch sich selbst Erkenntnisse erzeugt, und welchem der Philosoph bloß zusieht. Sein Geschäft in der Sache ist nichts weiter, als daß er jenes Lebendige in zweckmäßige Thätigkeit versetze, dieser Thätigkeit desselben zusehe, sie auffasse, und als Eins begreife. Er stellt ein Experiment an. [!] Das zu untersuchende in die Lage zu versetzen, in der bestimmt diejenige Beobachtung gemacht werden kann, welche beabsichtiget wird, ist seine Sache, es ist seine Sache, auf die Erscheinungen aufzumerken, sie richtig zu verfolgen, und zu verknüpfen, aber wie das Object sich äußere, ist nicht seine Sache, sondern die des Objects selbst, und er würde seinem eigenen Zwecke gerade entgegen arbeiten, wenn er dasselbe nicht sich selbst überließe, sondern in die Entwickelung der Erscheinung Eingriffe thäte. Der Philosoph von der ersten Gattung hingegen [*i.e. those who see the processes of knowledge as "dead" concepts*] verfertigt ein KunstProdukt. Er rechnet im Objecte seiner Bearbeitung nur auf die Materie, nicht auf eine innere selbstthätige Kraft desselben. Ehe er an die Arbeit geht, muß diese innere Kraft schon getödtet seyn, außerdem würde sie seiner Bearbeitung widerstehen. Aus dieser todten Masse verfertigt er Etwas lediglich durch seine eigene Kraft, und bloß nach seinem eigenen schon vorher entworfenen Begriffe (*28*, I, 4, 209-210).

Fichte's own use of the term "experiment" primarily underlines the need to view the observed as an activity itself, and to see thought as an activity, and, further, actively to conceive both processes as "Eins". As later with Novalis, philosophy and the objects of investigation are united in the act of the "experimentation" itself, although it is clear that Novalis adds an organic dimension, which is not present in Fichte's approach ("Alles kann zum Experiment - alles zum Organ werden" (*N*, 3, 391); "Der Organ[ism] wird durch den Philosophism complettirt und umg[ekehrt]" (*N*, 3, 403)).

Importantly, however, Fichte views the object under investigation as an activity or entity itself which cannot merely be compelled to give the answers the inquirer wishes, and in fact, "er würde seinem eigenen Zwecke gerade entgegen arbeiten, wenn er dasselbe [the object] nicht sich selbst überließe". This is remarkably similar to an inductivist's argument against a hypothetico-deductivist, for the inductivist would also say that the inquirer should not merely test his theory out on phenomena ("bloß nach seinem eigenen schon vorher entworfenen Begriffe"), but instead observe what the phenomena express. Thus, Fichte's notion of "experiment" which disparages both "dead" concepts and the notion of treating phenomena as if they were simply "dead" concepts, could be said to anticipate Novalis's view of the scientist's role in inquiry.

As has been discussed, Novalis's notion of "experiment" is not solely based on the particular sense of the term in the Baconian empirical tradition: it will now be shown that Novalis's use of the term entails a return to the original and ancient meaning of "experiment". It also relies much on some aspects of Neoplatonic thought. Importantly, the original meaning of "experiment", and Novalis's knowledge of Neoplatonic thought, add a further dimension to Novalis's notions of "Gefühl" or "Genie".

The traditional view of the Baconian meaning of empiricism, that of testing through "instances" and the return to experience in opposition to formal thought, overshadows the original meaning of "experiment", which always stressed experiential activity. The etymology of "experiment" goes back to the Romans, to the law courts and, indeed, to the arts in general. Frances Yates, when discussing the memory notions of the ancients, cites Quintilian, who observes that memory, like all arts, stems from "experiment". Quintilian's meaning of "experiment" is clearly that of a concrete form of knowledge, for he is referring to the use of images in the mind in the art of memory. The "experiment" itself is thus, importantly, a conscious recall to experience, and the arts use the method of "experiment" to carry out their business. Quintilian is here speaking of Simonides, the renowned inventor of the art of memory:[6]

> This achievement of Simonides appears to have given rise to the observation that it is an assistance to the memory if places are stamped upon the mind, which anyone can believe from experiment [*idque credet suo quisque experimento*]. For when we return to a place after a considerable absence, we not merely recognize the place itself, but remember things that we did there, and recall the persons whom we met and even the unuttered thoughts which passed through our minds when we were there before. Thus, as in most cases, art originates from experiment [*Nata est igitur, ut in plerisque, ars ab experimento*] (*88*, 2, 645 (11, 2, 17); *299*, 22).

It is clear here that "experiment" involves re-experiencing past experience, and putting the past experience into practice. Furthermore, it seems to be an activity involving the whole person, taking in memory, observation, mental acts and judgement. The ability to picture an event in the mind is a crucial part of this sense of "experiment". Moreover, in the Roman law courts, for instance, an "experimentum" was an attempt to make the jury think back to some past experience of their own which had similarities to the case at hand in the court. "Experiment" is, then, in this original sense, a conscious recall of experience; furthermore, it is similar in its rudiments to what one would now call "generative induction", a process of knowledge-gaining that builds on previous knowledge to construct new knowledge. The importance of this whole process for the development of science is now being recognized. Thus, to take one example, Nickles, a main campaigner for the concept of generative justification, in his essay 'Justification and experiment', explains the process of generative induction and its importance for the history of the sciences. He argues for the importance of practical knowledge and "know-how" in the making of claims about nature (*248*). Although Nickles does not deal with the etymology of "experiment", his own views on experimentation and its broad meaning go back to this original meaning of "experiment", which is quite the opposite of any hypothetico-deductive notion of experimentation or discovery. Nickles's idea of "know-how" can be compared to the ancients' use of previous experience, and concrete images, which are then employed in an art. "Know-how" refers to non-verbal forms of knowledge and extensions of verbal knowledge, which accords with the meaning of "experiment" for the ancients, since the arts were not conceptual, rather they were concrete, practical knowledge.

Novalis, in line with his natural philosophical interests, has a particularly organic view of the notions of "know-how" and experiential knowledge. He views experimentation and inquiry as a continual process and as part of life and organization itself. When Novalis speaks of philosophy and the organism mutually fulfilling one another ("Philosophism ist ein höheres Analogon des Organism") he sees them both as analogical and reciprocating entities. He thus continues to remark, underlining the essential "process" of knowledge:

Wer weis, was philosophiren ist, weis auch was Leben ist - und umgek[ehrt] (*N*, 3, 403).

His envisaged notion of inquiry, in its practice-orientation, is moreover highly piecemeal; he sees inquiry as a process "Schritt vor Schritt entwickelnd" (*N*, 3, 600). This same process of "limited" steps he sees, too, in Nature herself; Novalis draws similarities between structures and processes in Nature and man; both, in his view, operate in accordance with the same fundamental experiential processes:

Die Natur ist eine Kirche unendlicher Naturen. Alles ist beschränkt, auch des Menschen Wissenschaft soll nach Zeit, und Ort etc. bestimmt seyn (*N*, 3, 600).

Nature is composed of endless, but distinct, entities. In this sense inquiry, experimentation and philosophy, as a process of successive steps, are indeed the key to life, and vice-versa, "Leben" and our awareness of the need for strictly practice-oriented forms of knowing are the key to philosophy. In this way knowledge is part of the greater organized process of Nature. Nature is, too, as an endless organization, a creative, "experimental" process. In the first lines of *Die Lehrlinge zu Saïs* Novalis speaks of Nature as a "knowing" organized process, a process which man's activities are part of:

Mannichfache Wege gehen die Menschen. Wer sie verfolgt und vergleicht, wird wunderliche Figuren entstehen sehn; Figuren, die zu jener großen Chiffernschrift zu gehören scheinen, die man überall, auf Flügeln, Eierschalen, in Wolken, im Schnee, in Krystallen und in Steinbildungen ... erblickt (*N*, 1, 79).

In the "Chiffernschrift" of objects, processes and activities, Nature is equated with an "experiential", active notion of knowledge, since, in her various forms, Nature is revealing her organization.

Moving away from what one would consider to be the usual "scientific" realms of "experiment", i.e. the analysis and observation of phenomena, and continuing the line from Quintilian, it is to an "experimentation" of the imagination that Novalis often refers. A variety of views concerning the genre or rhetoric of experiment within the context of natural philosophy have been discussed. As remarked, Gooding's work (*176*) on Faraday's use of diagrams as non-verbal concepts comes close to Novalis's view of "experiments" in the imagination. Toulmin's notion of practical knowledge is of great relevance since he stresses the epistemology of experiential knowledge. Toulmin's work can also be applied to make the important distinction between the more formal-conceptual "thought experiments" of physicists and Novalis's stress on the experiential in "experiment", a notion illustrated in Toulmin's term of the paradigmatic type. This is a key difference and one overlooked, for example, by Moser in a recent article (*245*). Moser's article on the history of "Gedankenexperiment" and the link between the fictive experiments of literature and scientific experiments is both useful and illuminating. None the less, Moser fails to treat the epistemological factors of experiment and does not make reference to experiential knowledge. In so doing, Moser makes the differences between science and literature more apparent than they are by not doing justice to practical knowledge, which tends to point more to reality and experience than fiction or hypothesis.[7] What Novalis means by "experiments in the imagination" refers essentially to aesthetic productivity and its role in natural philosophical productivity itself. While Novalis does refer to the theatrical-rhetorical aspect of laboratory experiments, he would view this as part of his greater notion of the aesthetics of "experimentation" in the sciences and in philosophy. The latter, due to Novalis's concern for practical knowledge, is bound up in his interest in the epistemology of "experiment".

Novalis's notion of "experiment" is not restricted to individual actions, but to a particular kind of "experimental philosophy". Any thorough discussion of the term "experiment" must account for the whole process of experimentation, that is, all the possible influences on the experimental process itself. For Novalis this means we perceive and interact with the world around ourselves, and a major part of man's interaction with Nature in the process of inquiry for Novalis are the use of concrete notions and symbols. In his view not only are thought and external phenomena linked in the sense that they are both organizations, they are also bound together in their symbolization of one another:

Der Organ[ism] wird durch den Philosophism complettirt und umg[ekehrt]. Beyde Symbolisiren sich einander (*N*, 3, 403).

For Novalis, at the level of perception, a phenomenon can be elevated to a symbol, just as a particularly pregnant notion can be symbolic of a phenomenon or set of phenomena.

The sciences, and their object of investigation, the physical world, provided Novalis with the other half of his philosophy , which was not present in his earlier studies before his time at Freiberg. The study of matter makes the reciprocal symbolization of thought and external phenomena more fully possible. When

Novalis speaks of an "Experimentalphysik des Geistes" (*N*, 3, 387) he is referring to notions in the imagination which reciprocate symbolically with external phenomena. For the "Experimentalphysik" of the imagination would be "eine Algeber der Physik und Technologie" (*N*, 3, 387). To Novalis then, the notions of the imagination are symbolic formulas which mediate between theory and phenomena.

This other meaning Novalis attaches to "experimentation", distinct from the common meaning of "experimentation" oriented around the values of a hypothetico-deductive stance to inquiry, lies fully in the tradition of Neoplatonism and the use of symbols of the imagination as part of a method for gaining knowledge. In fact, this sensual-imaginative tradition also finds an ardent adherent in Bacon, for this is an important side to his notion of knowledge; according to Frances Yates, it is his "most notable contribution to science", as she argues when speaking of his style:

> And the intensive concentration on images in the literary style is related to that search for "real characters", for a notation which should make direct contact with reality, which was perhaps Bacon's most notable contribution to science, leading, as it did, to the search for universal languages, and thence, eventually, to Leibniz (*300*, 69).

Yates comments further, when speaking of Bacon's use of myth to come closer to reality than discursive reasoning:

> This again ties up with Bacon's advocacy of "real characters", the use of signs having a direct contact with reality, which he regards as one of the basic necessities for the advancement of science. This idea has an obvious connection with magic signs, but, again, Bacon's treament of it is detached and rational.
> This brings us to Bacon's belief in the importance of the art of memory - a reformed art of memory, not used with pretentiousness and pride (perhaps he was thinking of Bruno's and Fludd's magic arts of memory), but humbly, as an instrument of scientific classification and method ... It may be that it is on these lines - in the search for a "real" notation, for a universal language using "real characters", and for a method incorporating Lullism, Ramism, and the art of memory - that Bacon's greatest importance will be seen to lie in the scholarship of the future, as it traces these strands from the Renaissance to Leibniz ... On the problem of the mental image and changing attitudes to it - an absolutely central one for the history of our civilization - Bacon again stands between two worlds.

On the one hand he knows, still at first hand to speak, of the Renaissance imaginative magic; on the other he begins to detach himself from it. When events like these, occurring within the psyche, are better understood, we may come at last to a better understanding of the great turning points in history, such as the modulation of Renaissance into seventeenth century (*300*, 65-66).[8]

Novalis was aware of this side of Bacon's thought, and refers to the concrete notation that Bacon was seeking for the furtherance of inquiry as "die indirecte Erfindungskunst" (*N*, 3, 128). Novalis thereby links this part of Bacon's thought to his own notion of discovery and his notion of the use of symbols in inquiry (see also below, chapter 2, section 1.4).

Moreover, the Baconian inductive method itself, in the way it moves towards greater generalizations, is also to an extent symbolic, since the generalizations are symbolic of many phenomena. They may have been gained inductively, but as generalizations they are symbolic idealizations of phenomena.

The inner logic of the mind and its symbolic notation as espoused, for example, in Bruno's method or the making of Leibnitz's calculus has, naturally, considerable relevance to scientific method itself. Had Novalis known of Bruno's endless systemizing and combinations of his wheels he would surely have called him an "experimenter" of the highest order. Novalis does indeed think very highly of what he refers to as Leibnitz's "herrlicher Versuch" at the "heiligen Weg zur Physik" (*N*, 3, 469), undoubtedly a reference to Leibnitz's vast "Combinatorik" programme, where a universal notation was sought. The importance of this whole tradition, as it leads to Leibnitz, for Novalis, further emerges when Yates cites Couturat on the significance of Leibnitz's concrete notation for the sciences:

"And indeed", says Couturat, "there is no doubt that his [Leibniz] most famous invention, that of the infinitesimal calculus, arose from his continual search for new and more general symbolisms, and that, inversely, this invention confirmed him in his opinion of the capital importance for the deductive sciences of a good characteristic." Leibniz's profound originality, continues Couturat, consisted in representing by appropriate signs, notions and operations for which no notation had hitherto existed. In short, it was through his invention of new "characters" that he was able to operate the infinitesimal calculus, which was but a fragment, or a specimen, of the never completed "universal characteristic" (*299*, 384; *157*, 84, 85).

This whole tradition of "experimentation" with signs or images in the imagination is, too, in other Neoplatonic forms, directly bound up with empirical experimentation in the laboratory; it can be seen, for example, in the use of symbols to assist alchemical inquiry; and these notions survived into Novalis's time, as can be seen by the development of alchemical signs into chemical affinity tables.[9]

Novalis's own notion of "die Experimentalmethode" (*N*, 3, 123) refers to the employment of a concrete *a priori* form of knowing and is applicable as a general method of inquiry. One can rightly use the term "concrete *a priori*" since Novalis is well versed in the language of German Idealists, and is well aware of the difference between, for example, a Kantian synthetic *a priori* judgement and a Cartesian analytical concept. In particular, Novalis's intellectual development shows an attempt at unifying the German Idealism of Kant and Fichte with a broader concept of knowledge that has Neoplatonic orientations. In Hemsterhuis and Plotinos Novalis found the notion of "Sympathie", and in Hemsterhuis, too, the idea of a "Combinatorik". It was on this Neoplatonic idea of "Sympathie" that Novalis to a some extent based his own method involving the concrete notation of the imagination. When Novalis speaks of "Gefühl" or "Genie" he is referring to the power of "Sympathie" in man, and man's innate ideas, and the employment of concrete notation as part of a working method of inquiry, a type of concrete "Calcül". Through "Sympathie" a bond was formed between the observer and external phenomena, literally, in Novalis's view, allowing the inquirer to work in "sympathy" with Nature.[10]

This shift in Novalis's development is of interest for a model of scientific inquiry itself, for the use of a concrete *a priori* assists in building a model for inquiry that can take account of how theory is developed. For Novalis's adaption of Kant and Fichte to the thoughts of Hemsterhuis and Plotinos brought about his notions of scientific and natural philosophical productivity. Fichte did not treat the sciences in any detail, and Kant was not prepared to stretch his own views of aesthetics so categorically as Novalis does to scientific and natural philosophical productivity. In the light of Novalis's view of the role of aesthetics in inquiry, the scientific "experiment" itself gains a particular status: firstly, as a showpiece of theory; and secondly, as the very concrete link between man's thoughts and the phenomena. The "experiment" (as also for Goethe in his *Der Versuch als Vermittler zwischen*

*Objekt und Subjekt* (*41*)) effects the relationship between subject and object: thus the "experiment" itself is a form of concrete knowledge. Here, for Novalis, aesthetics and science meet in natural philosophical productivity. Regarding scientific procedure, Novalis's use of the term "experiment" implies a process of "ideal" induction where knowledge is accumulated from what we know already as experience, both in a strictly empirical sense of practical "know-how", and in the extended sense of our innate ideas of Nature. In this way, the subject is employed in inquiry to mediate between phenomena and theory in the act of experimentation. (Historians of science such as Gooding or Nickles would refer to "know-how" in its broader sense as all non-verbal forms of knowledge (*176*, 192; *248*, 329).)

Further what makes the term "experiment" so useful, and not only with regard strictly to science, is that it is a constant reminder of the very nature of inquiry and knowledge; to Novalis, it underlines his belief that knowledge is a process and a phenomenon itself, for the "experiment" is an event or activity. In this manner, the "experiment" is a constant symbol of what knowledge is and how it is created, the "experiment" itself draws conceptual views of knowledge, formal theory and indeed speculation back into experience itself. Thus one can say that Novalis's idea of "experimental" knowledge is not only a experiential method for knowledge formation, but also part of a particular attitude. A famous example of a similar attitude is Samuel Johnson's refuting of Berkeley's idealism by kicking a stone. Perhaps for Johnson his action was a call for a return to common sense, but for Novalis such an instance would also be symptomatic of an attitude that demands continual mediation between theory and phenomena: knowledge, in Novalis's view, should always be drawn back into life and experience. With specific reference to his own views on inquiry Novalis remarks:

Diogenes Gehn - war *Experimentalphil[osophie]* - ächtsynth[etische] Phil[osophie] (*N*, 3, 439).

This remark refers to the occasion when Diogenes "proved" an opponent's denial of motion wrong by simply walking (*23*, 1, 313; *24*, 2, 263-4 (6, 39)).[11] This example is, interestingly enough, used by Fichte (for a practical notion of knowledge, although at a different level to Novalis), and this is undoubtedly Novalis's source.[12] The "steps" taken by Diogenes throw light on several aspects of Novalis's experimental stance: firstly, on his view of the very nature of an "experiment", namely that it is an instance of a phenomenal proof or statement on

Nature, and can be used in inquiry as a point where theories can be decided upon. The "steps" also demonstrate Novalis's belief that knowledge is, in essence, experience itself, here simply the "steps" taken by Diogenes. Significantly, Novalis refers to Diogenes's steps as "ächtsynth[etische] Phil[osophie]". This is a clear allusion to, and extension of Kant's notion of knowledge. The "steps" espouse a notion of the *a priori* going beyond the Kantian "synthetic *a priori* judgement" and refer to natural philosophical productivity and also a broad notion of experiential "know-how". In the scientific context of the idea of "motion", Novalis refers here to Diogenes's form of philosophizing as genuine "Experimentalphilosophie", a reference to the empirical tradition, for what Diogenes does is to remain close to the phenomena, and not try in hypothetico-deductive manner to prove a theory. Diogenes's walking is indeed the epitome of Novalis's notion of experiential knowledge, for the "steps" can be seen as the realization of an innate idea, and the "steps" were the visible employment of "know-how". For Diogenes instinctively must have felt that the idea that motion did not exist was wrong, and his "know-how" must have told him that motion was continuous. What Novalis sees as an "experiment" of the imagination, that is, the bringing forth of an innate idea or the employment of "know-how", has actually been realized in the steps Diogenes took; the "proof" of Diogenes's notion of motion was communicated non-verbally as an activity itself. In his steps, theory and phenomena were succinctly bound together, his "theory" of continuous motion was thus put to the test, and his "experiment" was a highly visible showpiece of his "theory". The rhetoric of Diogenes's "experiment" does not lie alone in its dramatic qualities. Diogenes "experiment" is also a small scale demonstration of the aesthetic elements in Novalis's notion of natural philosophical productivity. Diogenes's "know-how" or practical knowledge are a type of aesthetic knowledge since they are forms of concrete thought. Here we can also see the relevance of Toulmin's notion of paradigmatic types and his reference to Aristotle's "phronesis": Diogenes's "steps" are a form of knowing that links morality, the aesthetics of the imagination, and scientific knowledge. By taking his steps Diogenes "hits the mark".

It is clear that Novalis's reference to Diogenes's "steps" as genuine "Experimentalphilosophie" is a major point of reflection. Essentially, Novalis is remarking that there are many forms of "theorizing", be they aesthetic, moral or scientific. In his notion of experiential knowledge he is referring to the many and varied forms of experiential knowledge, the many ways of drawing knowledge back into life and experience, and the many forms of "experiment", in all of man's activities. To conclude, Novalis's notion of "experiment" goes beyond the standard scientific viewpoint to mean, firstly, the dismissal of hypothetico-deductivism in favour of a piecemeal ideal induction using concrete notation. This meaning of "experiment" is essentially concerned with the aesthetics of natural philosophical productivity. The second strand in Novalis's meaning of "experiment" points to his fundamental attitude to knowledge: inquiry, "Leben", and Nature as a whole organization, all operate "experimentally". Knowledge, for Novalis, is always drawn back into experience. "Experimentiren", to Novalis, is the key to life itself: to both understanding life, and the key to the processes of life. These two strands in his notion of "experiment" accord in general with the epistemological and pluralist, active or passive patterns in his thought.

Chapter Two

# The emergence of Novalis's notion of "experiment".

# 1. The "experiment".

## *1.1. Hemsterhuis: Sympathie and Combinatorik.*

Having provided some introduction to what "experiment" and experimental philosophy meant to Novalis it is now time to study his reaction to other thinkers in his works. Noticeable in Novalis's intellectual development is above all his understanding of contemporary thought, both in the sense of German Idealism and contemporary science, and his assimilation of contemporary thought into the Neoplatonic tradition. This is a clear sign of his highly historical and reflective approach to knowledge.

A major contemporary influence was Hemsterhuis. As Mähl has shown, Hemsterhuis provides Novalis with insights into the Neoplatonic tradition, particularly concerning the notions of the Golden Age and "Sympathie". Mähl writes on Novalis's interest in the Dutch philosopher:

> Was ihn [*Novalis*] vor allem anzog, war wohl die Idee der Liebe, wie sie bei Hemsterhuis, in der ihm eigentümlichen Verbindung neuplatonischer Gedankengänge mit den Erkenntnissen der modernen Naturwissenschaft, zur metaphysischen Weltmacht erhoben worden war (*331*, 267).

Hemsterhuis himself remarked:

> Ce principe que vous sentez si bien, mon cher Aristée, cet amour, cette pente vers une union d'essence avec des êtres ou des choses quelconques, est une faculté qui lie en quelque façon les êtres ensemble, et qui agit en raison de l'homogénéité (*50*, 2, 58).

Love and, as it is otherwise known, "Sympathie", was further a universal law to Hemsterhuis; he conceived of this ancient force in a modern way, by analogy with the law of attraction operating in matter, namely as a specific power, God-given, and inherent in human "essence":

[...] une loi qui dérive de notre essence, que Dieu a donnée aux êtres libres et actifs, pour s'aimer, pour s'unir ensemble; comme il a donné à la matière la loi d'intertie ou d'attraction, d'où dérive la réaction contre toute action contraire à cette loi [...] (*50*, 2, 98).

Hemsterhuis's formulation of the idea of "Sympathie" was particularly appropriate for Novalis. For here was a law that most ideally drew Novalis's scientific and spiritual interests together, since essentially the same force was at work in man and in Nature. A further aspect of Hemsterhuis's concept of "Sympathie" was also crucial for Novalis. This was Hemsterhuis's notion of man's "moral organ", which operates in accordance with the universal "sympathy". The force within all being cannot, in Hemsterhuis's view, be apprehended directly by the senses, but only by this human ("moral") organ:

[...] cet organe, qui est tourné vers les choses divines, comme l'oeil est tourné vers la lumière (*50*, 2, 100).

This concept became a standard part of Novalis's conceptual framework, and is often mentioned in his writings.[1] In contrast to the sense-organs, the path to knowledge through this organ was inwards:

Il faut entrer dans nous-mêmes (*50*, 2, 95).

There is an obvious echo of this idea in Novalis's famous fragment in *Blütenstaub*, "Nach Innen geht der geheimnißvolle Weg" (*N*, 2, 419). Closely connected to this concept is Hemsterhuis's ranking of poetry as the highest form of knowledge, another element attractive to Novalis; for Hemsterhuis, the workings of the "moral organ" were most apparent in the creative imagination. Here lies the root of Novalis's notions that knowledge has to be "poeticized" or "romanticized", and indeed his notion of "Genie" has its roots here as well, as Mähl argues (*N*, 2, 315-316).

Most important for Novalis's knowledge programme is the "sympathy" between man's ideas and natural phenomena as expounded in Hemsterhuis's work *Lettre sur l'homme et ses rapports*. Here Hemsterhuis explicitly refers to the possibility of overcoming the split of mind and matter:

Si l'homme avoit les idées de tous les rapports, et de toutes les combinaisons de ces objets, il ressembleroit à Dieu, pour ce qui regarde la science, et pour ce qui regarde l'état de l'univers, autant que nous le connoissons, et sa science seroit parfaite (*50*, 1, 228).

Here one may find one source for the beginnings of Novalis's notion of a "Combinatorik". During his scientific studies at Freiberg, Novalis then develops a progressive method of inquiry based on this very "sympathy" between ideas and phenomena. Novalis wrote down in response to Hemsterhuis:

Die Wissenschaften sind nur aus Mangel an Genie und Scharfsinn getrennt - die Verhältnisse zwischen ihnen sind dem Verstand und Stumpfsinn zu verwickelt und entfernt von einander.
Die größesten Wahrheiten unsrer Tage verdanken wir solchen Combinationen der Lange getrennten Glieder der Totalwissenschaft (*N*, 2, 368).

The many "separate" forms of knowledge are to be reunited through the use of the innate ideas of the genius or poet, operating by "Sympathie". It is important to understand that the "Combinatorik" does not just mean a comparison of the disciplines or various types of knowledge; "Combinatorik" primarily means, as in the rudiments of calculus, its mathematical form, the use of symbols and notation that correspond to phenomena, or, as Hemsterhuis puts it, "les rapports". This remark of 1797 was clearly of such importance that Novalis inserted it into *Das allgemeine Brouillon* in 1798, along with other remarks on Hemsterhuis (*N*, 3, 275). What Novalis sketches in 1797 after reading Hemsterhuis is developed later in his notion of scientific and natural philosophical productivity, where concrete notions, models and idealizations are used to discuss the sciences and discovery processes themselves.

Novalis's references to the Golden Age also seem inspired by Hemsterhuis, who speaks of a past and the possibility of a new Golden Age through the power of love or "Sympathie" in man, as Mähl has shown (*331*, 272). This idea adds an important dimension to Novalis's notion of inquiry, too, and covers him again against those who are too quick to interpret his ideas of knowledge absolutely, as being purely idealistic. For the final goal of Novalis's inquiry was indeed the Golden Age of total "Sympathie", when knowledge would be all experience, when man would be in perfect accordance with Nature; but inquiry to Novalis was always seen in the light of the Golden Age, as something as yet unobtained, but which inquiry had the potential to move gradually towards.[2]

Critics have pointed out how Novalis's views do, however, conflict with Hemsterhuis's determinism, for Novalis, unlike Hemsterhuis, did not see man's role in the universe as passive, although as discussed there are passive elements in his thought. However, Novalis, in keeping with his notion of progressive inquiry and the "experiment" of life itself, believed that man had the potential to change Nature (*339*, 81; *331*, 269-270).

*1.2. Kant: practical knowledge and philosophy as an "experiment". Novalis's shift to the aesthetics of scientific productivity as natural philosophical productivity.*

Hemsterhuis was, then, the person who upheld that man could gain knowledge innately from within, and is a major marking post for Novalis's development. Indeed, as Mähl argues, Hemsterhuis was for Novalis the prophet of the coming German Idealism, which then came into existence in the figure of Kant, and was completed and expanded by Fichte (*N*, 2, 335). This is an important point to bear in mind when considering Novalis's development, for Novalis, although steeped in the German Idealism of Kant and Fichte and their terminology, works extensively to assimilate this modern form of Idealism with Neoplatonic viewpoints.

It would seem appropriate to discuss Novalis's relationship to Fichte before approaching Kant, since this is more the order in which Novalis himself made in-depth studies of German Idealism. Novalis studied Fichte in 1795 and 1796, came to Hemsterhuis in 1797, and the studies of Hemsterhuis led him, as mentioned, to turn to Kant in the same year. These *Kant-Studien* are an important point of reflection in Novalis's intellectual development. Mähl comments on the chronology and development of Novalis's interests:

> Dennoch hat bei Hardenbergs *Kant-Studien* offenbar ein besonderer Anlaß mitgewirkt. Die Beschäftigung mit Hemsterhuis hatte ihn in der Überzeugung eines von Fichte unabhängigen Standpunktes bestärkt. Eben dieser Augenblick mußte ihm, der zwischen Fichte und Hemsterhuis seine eigene Position zu ergründen hätte einen erneuten Rückgang auf Kants "Kritik der reinen Vernunft" reizvoll erscheinen lassen - einen Rückgang auf den Boden und Ursprung der Transzendentalphilosophie, von dem aus Hemsterhuis als "Prophet des transcendentalen Idealismus" und Fichte als sein kühnster und einseitiger Vollender begriffen werden, zugleich aber auch der eigene Ansatz selbstständig weiter verfolgt werden konnte (*N*, 2, 335).

Elsewhere Mähl further shows that Novalis's renewed interest in Kant lay specifically in his interest in finding links between Kant's "theoretischen" and "praktischen Vernunft". Novalis found the link in "Poesie" - in the imagination - and Mähl views these reflections in the *Kant-Studien* as the "Geburtstunde des Romantikers Novalis" (*329*, 68).

One can also say that the reason for Novalis's renewed interest in Kant lay in his urgent need to find out how Kant linked philosophy to natural philosophy.[3] Of course, the dynamism of Kant's own natural philosophy would have attracted Novalis, but Novalis was essentially searching for something else: what I would call his own notion of natural philosophical productivity. The latter ought, arguably, also to be understood as Novalis's poetics; and these need to be seen, for their part, in terms of his overall project to link man's consciousness with Nature's purposiveness. This search had been stimulated in the broad terms of Hemsterhuis's ideas - which can themselves be interpreted as a type of a natural philosophy. Ironically, but also understandably enough, Novalis found answers to his questions not in Kant's *Metaphysische Anfangsgründe der Naturwissenschaft*, but instead, as has been seen, in Kant's critical works. In the *Kritik der reinen Vernunft* Kant speaks of his undertaking as an "experiment" and Novalis jots down "Experimentalmethode der reinen Vernunft" (*N*, 2, 386). This idea of conducting an "experiment" on the object of knowledge and of treating knowledge as an activity causes Novalis to remark further:

Wir *erkennen* es nur, *insofern* wir es *realisiren* (*N*, 2, 386).

This experiential approach to philosophizing causes Novalis to reflect upon philosophical style, and he reacts to Kant's call for a "Wissenschaft" (i.e. a methodology) for philosophy in the following way:

[..] philosophiren ist soviel, als *wissenschaften*, Gedanken durchdenken, Erkenntnisse erkennen - die *Wissenschaften* wissenschaftlich und *poetisch* behandeln. Sollte *practisch* und poetisch eins seyn - und lezteres nur absolut practisch in specie bedeuten? (*N*, 2, 390).

For Novalis, philosophy is its own activity, and is both theoretical and poetic at the same time. Novalis here further poses the fundamental question as to whether practical philosophy and, indeed, it would appear to be intimated, the sciences, are not actually a form of aesthetics themselves. In this way, Novalis suggests that poetry, too, is perhaps but one form of practical philosophy. Here we can see Novalis circling around the links between theoretical, practical and aesthetic knowledge. Kant was not willing to apply practical reason to theoretical reason, but Novalis's comments suggest that he saw just that evinced in the "experiment" of the *Kritik der reinen Vernunft*. We can now see that it was not so much Kant's notions of epistemology in his *Kritik der reinen Vernuft* that effected Novalis, but his philosophical style itself. As ever, Novalis is concerned with notions of productivity, and his circulation around the terms "praktisch" and "poetisch" point further to the fact that he is concerned with the broadest form of productivity, that of his notion of natural philosophy.

Thus, in the *Kant-Studien*, it is in terms of Hemsterhuis's "Sympathie", the universal force of the physical and metaphysical realms, that Novalis asks if there are forms of experiential knowledge other than those stipulated by Kant in his notion of theoretical reason. Having questioned Kant's "Begriff von Sinn" and the meaning of Kant's "inneren" and "äußeren Sinnlichkeit", Novalis then poses the question:

Giebt es noch *außersinnliche* Erkenntniß? Ist noch ein anderer Weg offen, aus sich selbst herauszugehn und zu andern Wesen zu gelangen, oder von ihnen afficirt zu werden? (*N*, 2, 390).

What Kant only allows for aesthetics and morality - attributes which do themselves admittedly point to the notion of an experiential whole - Novalis wishes to apply to the sciences.[4] The sort of experiential whole Novalis is referring to is, naturally, the magic bond between man's inner thoughts and the world outside as entailed by Hemsterhuis's universal force of "Sympathie". This is a theme which Novalis incorporates into his thought, and is the key to his notion of "Combinatorik" which he later develops in 1798, where innate ideas and empirical work are linked in a single inquiry.

After the *Kant-Studien* of 1797, Novalis once again returns to Kant in 1798, in the *Freiberger naturwissenschaftliche Studien*, with "experiment" and natural philosophical productivity in mind. On this occasion, however, Novalis is more precise in his views and gives clear indications about the aesthetic elements in scientific productivity when he speaks of "die Beobachtungsmethode" and "die Experimentalmethode" (*N*, 3, 123). Before elaborating on these terms, it is worthwhile discussing some of the issues surrounding philosophy and the sciences in *Die Kritik der reinen Vernunft*, which is the work that Novalis primarily directs his comments at.

Kant's reassertion of man's intellectual abilities through the founding of a theory of knowledge based on the subject in his proof of *a priori* knowledge would, of course, have appealed to Novalis's own recourse to the subject and his view that the key to truth lies within man. Important, too, for Novalis's idea of knowledge and experience is that Kant constructed a philosophy which steered between empiricism and Rationalism. Kant castigates the Rationalists for only seeing knowledge in pure logic or thought, and uncovers the empiricist's fallacy that there is no knowledge outside of experience.

Kant tackles empiricism and Rationalism from the point of view of objective and general knowledge, and it is his new concept of what can be considered as "allgemein und notwendig" that blends the two schools of thought. For Kant, objective knowledge is not just made up of experience (empiricism), nor does it only consist of thought (Rationalism). Kant shows that knowledge is comprised of sensual experience ("die Anschauung") and experience-free concepts (*a priori* ideas).[5]

Within his critical metaphysics Kant searches for all knowledge that is "transzendental", that is all knowledge which is a prerequisite for our understanding of the world. In the introduction to *Die Kritik der reinen Vernunft* he calls "alle Erkenntniß *transzendental*, die sich nicht sowohl mit Gegenständen, sondern mit unserer Erkenntnißart von Gegenständen, sofern diese *a priori* möglich sein soll, überhaupt beschäftigt" (*62*, 3, 43). In his theory of *a priori* knowledge Kant seeks to define a deeper, objective layer of inner experience. Höffe explains, "Untersucht werden die erfahrungsunabhängigen Bedingungen objektiver Erkenntnis, die in der vor-empirischen Verfassung des Subjekts liegen" (*199*, 54). Kant's new form of metaphysics does not serve to increase our knowledge of metaphysics nor of the sciences, he intends only to add a critical dimension to our knowledge, although, in doing so, he is necessarily providing the metaphysical basis of all knowledge. His notion of metaphysics does not mean to further speculation or the accumulation of knowledge; as he says, it serves "nicht zur Erweiterung, sondern zur Erläuterung unserer Vernunft" (*62*, 3, 43). Kant calls his metaphysics "eine Logik der Wahrheit" (*62*, 3, 87), and this implies that he is not searching for the meaning of truth, nor is he assessing which other aspects of man's knowledge are true, as for example in the sciences. Höffe comments on Kant's *Kritik*, "Sie sucht weder - semantisch - nach der Bedeutung von "Wahrheit" noch - pragmatisch - nach einem Maßstab, um entscheiden zu können, welche Aussagen(systeme) wahr sind" (*199*, 68). Kant is, rather, searching for the conditions of objective statements.

Moreover, looking at Kant's notion of knowledge in more detail and his demarcation of the rest of knowledge, Kant did not see truly objective knowledge in general lying in the sciences or in mathematics. He saw this only in the principles of the *a priori* as expounded in the "transzendentale Kritik", and these he understands as "die reinen Anschauungsformen, die reinen Begriffe und Grundsätze" (*199*, 69). Kant does not include the individual sciences in his notion of knowledge, apart from mathematics and physics, because they are not, in his view, *a priori* proven, as Höffe endorses, citing Kant, "Zur 'eigentlichen Wissenschaft' gehört, daß ihre Gewißheit apodiktisch (notwendig) ist; 'Erkenntniß, die blos empirische Gewißheit enthalten kann, ist ein nur uneigentlich so genanntes *Wissen*'" (*62*, 4, 468; *199*, 60). To be precise, above all, *a priori* knowledge must have synthetic character, and this refers to a form knowledge that is not conceived by analysis and logic. Analysis operates under semantic rules using the statement of contradiction in order to form logical laws. Analytical judgements, in Kant's opinion, only elucidate our knowledge of the subject, and do not add anything new to the subject:

Z.B.wenn ich sage : alle Körper sind ausgedehnt, so ist dies ein analytisch Urtheil. Denn ich darf nicht über den Begriff, den ich mit dem Wort Körper verbinde, hinausgehen, um die Ausdehnung als mit demselben verknüpft zu finden, sondern jenen Begriff nur zergliedern, d.i. des Mannigfaltigen, welches ich jederzeit in ihm denke, mir nur bewußt werden, um dieses Prädicat darin anzutreffen; es ist also ein analytisches Urtheil (*62*, 3, 34).

Distinct from analytical judgements, synthetic judgements do increase our knowledge of the subject, for the predicate brings something new into relation with the subject:

Dagegen, wenn ich sage : alle Körper sind schwer, so ist das Prädicat etwas ganz anderes, als das, was ich in dem bloßen Begriff eines Körpers überhaupt denke. Die Hinzufügung eines solchen Prädicats giebt also ein synthetisch Urtheil (*62*, 3, 34).

The principles of mathematics, or particularly of geometry, are composed of synthetic *a priori* knowledge. In fact Kant sees all mathematical judgements as "synthetisch" because they operate using synthetic principles as their base, even though the mathematical method appears to take an analytical form. For the sciences, and here Kant implies physics, only the principles are considered as synthetic *a priori* knowledge, and in *Die Kritik der reinen Vernunft* he gives Newton's third Law as an example, "Ich will nur ein paar Sätze zum Beispiel anführen, als den Satz, daß in allen Veränderungen der körperlichen Welt die Quantität der Materie unverändert bleibe, oder daß in aller Mittheilung der Bewegung Wirkung und Gegenwirkung jederzeit einander gleich sein müssen" (*62*, 3, 38). However, although Kant rated mathematics and physics so highly, in the sense of his philosophy they do not exemplify the essence of experiential knowledge. What the sciences were in need of, he thought, was a base for their objectivity. The "transzendentale Kritik" is not trying to compete with the sciences or argue for any particular scientific method: it aims to discover an objective relationship to possible experience. Since his *a priori* knowledge relates knowledge to real objects, in his undertaking Kant has greater interest in objective statements than in the objects themselves because they lie deeper in experience, and so he tackles the layer of experience behind the sciences.

Thus, for example, the *a priori* "Anschauungen" in geometry serve only to assist in the search but are no basis for an objective knowledge of experience, as Cassirer confirms: "Indessen bildet auch für die Geometrie, wie man sieht, die 'Anschauung' hier nur ein technisches Hilfsmittel, dessen sie sich bedient, nicht aber den Rechtsgrund, auf dem ihre Wahrheiten beruhen" (*152*, 591).

Kant does, naturally, have a special place for mathematics and physics in the sense that he sees external nature governed by the Newtonian laws, and further, that he bases the possibility of his transcendental *a priori* knowledge on the fact that *a priori* knowledge was already firmly grounded in mathematics as part of a long established tradition. However, his final stance to mathematics and physics is that they form the premises for objectivity, but are not the goal of objectivity. Transcendental forms of knowledge, as Höffe concludes, "heißen jene Voraussetzungen, die weder mathematischen noch physikalischen Charakter haben und doch immer 'am Werk' sind, wenn wir Mathematik oder Physik betreiben" (*199*, 67).

Turning now to Novalis's comments in 1798 on Kant's epistemology, in the *Mathematische Studien zu Bossut und Muhrhard* in the *Freiberger naturwissenschaftliche Studien*, Novalis notes down the following from a remark of Muhrhard's concerning Kant's epistemological differentiation between philosophy and mathematics:

Kant bestimmt, als *wesentl[ichen] individ[uellen] Karacter* der math[ematischen] Methode - daß d[er] Mathem[atiker] nicht discursiv, wie der Phil[osoph] - sondern *intuitiv* verfährt - nicht aus *Begr[iffen] schließt*, sondern seine Begr[iffe] construirt - *sinnlich* darstellt - aber activ sinnlich - oder reine Ansch[auung] bildet (*N*, 3, 122-123).

This comment refers to the synthetic and experiential nature of the mathematical method. Novalis reacts to the idea by arguing that mathematics is not the only discipline where such experiential and, in the Kantian sense, synthetic notions are formed:

Auch hier ist das Verfahren d[es] Mathem[atikers] wie mich dünkt, nicht individuell ... Warum soll dies der Phil[osoph] nicht auch thun - oder überhaupt jeder einzelne wissenschaftliche Meister - In allen W[issenschaften] soll selbstthätig plastisirt werden (*N*, 3, 123).

Besides extending the entire framework, Novalis importantly introduces a term which is decidedly non-Kantian, that of "Plastisirung". The concept undoubtedly comes from his reading of Herder's *Plastik* at this time (*N*, 2, 650; see below). In this combination of Kantian and Herderian ideas, one sees Novalis's own "Combinatorik" at work in his absorption of Kant. The remark has significant consequences. The notion of "Plastisirung" also provides a bridge to Goethe. A remark of Novalis's from his essay *Über Goethe* written at the same time serves to show that when Novalis was, at this time, thinking of abstracting from phenomena in the remark on Kant, he probably also had Goethe's (as well as Herder's) notions of concrete knowledge in mind:

An ihm [*Goethe*] kann man die Gabe zu abstrahiren in einem neuen Lichte kennen lernen. Er abstrahirt mit einer seltnen Genauigkeit, aber nie ohne das Object zugleich zu construiren, dem die Abstraction entspricht (*N*, 2, 641).

In both the comment on Kant and that on Goethe, Novalis is speaking of concrete forms of knowledge that imply a much broader notion of scientific productivity than did Kant. Indeed, this breadth, and the parallel notions of "plastisiren" and "construiren", actually calls Kant's notion of science into question, for Novalis is clearly demanding a more encompassing and concrete notion of synthetic experiential knowledge. Novalis wishes to bring aesthetics into the sciences on a far broader scale and use aesthetics centrally at a constitutive level, as opposed to Kant's regulative level. As already mentioned, Kant's notions of aesthetic and teleological appraisal in his *Kritik der Urteilskraft* do treat the ordering of nature in terms of perception, the imagination and understanding. This stance has many affinities with, and is a forerunner of, Romantic natural philosophical endeavours. Romantics such as Novalis and Schelling were thus both extending Kant's programme and questioning Kant's strict notion of science. Novalis defines the boundaries between himself and Kant by calling the use of concrete notions, in distinction to what Kant refers to as the synthetic knowledge of mathematics, the "experimental method":

Die Plastisirungsmethode ist die ächte Experimentalmethode (the *N*, 3, 123).

This remark is of fundamental importance for Novalis, and illustrates his position vis-à-vis Kant. Indeed, in my view, this remark lies at the heart of Novalis's notion of natural philosophy. Novalis is saying three things. Firstly he argues that aesthetics is a part of scientific productivity, as the term "Plastisirung" implies. Secondly, he is asserting his notion of "experiment". Both elements of Novalis's idea of "experiment" feature here: "Plastisirung" points to the use of concrete thought and notation in a process of inquiry based upon ideal induction. This is Novalis's rhetoric of "experiment" which is concerned with the aesthetics of natural philosophical productivity. The other element of Novalis's meaning of "experiment", that inquiry, life and Nature are all "experimental", i.e. that knowledge is always drawn back into experience, is illustrated here in the fact that Novalis's wishes all the disciplines to employ aesthetics ("überhaupt jeder einzelne wissenschaftliche Meister"). Thirdly, he emphasizes that mathematics, the science that Kant rated above all, is not the only science which is capable of producing synthetic *a priori* knowledge. Indeed, Novalis goes further to suggest that the mathematical method is, in the sense of a stance to inquiry, more deductive and conceptual, more akin to the distanced observing of phenomena. Novalis by no means negated mathematics, for it, too, at a higher level operated according to "Sympathie" using concrete notation; it is, rather, that here, when he uses the term of the "mathematical method", he is referring to the more discursive, conceptual part of man's thought:

Die Umgekehrte, mathematische Methode bestände in *Construction der Anschauungen*, im Gegensatz der Begriffe - ... in Bildung *reiner Gedanken* - in Fixirung *des Anschauens* (Sinnens) durch Gedanken ... Die Begreifungs, oder Erkenntnißmeth[ode] ist nichts, als die ächte *Beobachtungsmethode* (*N*, 3, 123).

Novalis's notion of a "Beobachtungsmethode" is a process moving from concrete thought to formal forms of thought. Concrete thought ("Anschauuung") is converted into "reine Gedanken". This process is more the deductive and analytical method in distinction to the inductive and synthetic "Experimentalmethode". Novalis further comments that the "Experimentalmethode" produces "Figuren", i.e. the symbols of concrete thought, whereas the "Beobachtungsmethode" produces "Worte", i.e. the more discursive forms of knowing (*N*, 3, 123).

In these remarks Novalis is clearly alluding to his grander notion of natural philosophical productivity, for he goes on to speak of the Golden Age to come, when man will be "plasticizing", that is, making his thoughts real by "experiment", for then his ideas will be in harmony with Nature, his concrete notions will be direct correlatives of natural phenomena. Not only will man be "plasticizing", but also have such a direct contact to phenomena, that he will directly perceive Nature as a "language", and convert the language of her "figures" into words:

Das wird die goldne Zeit seyn, wenn alle Worte - *Figurenworte* - ... und alle Figuren - Sprachfiguren ... seyn werden - wenn man Figuren sprechen und schreiben - und Worte vollkommen plastisiren ... lernt (*N*, 3, 123-124).

In short, knowledge will become experience itself, and man would be carrying out the empirical ideal of directly apprehending Nature.

Important to note is that Novalis is not so absolute in his stance as the ideal of the Golden Age may make him appear, since he suggests a process of induction and deduction ("Plastisirungsmethode" and "Beobachtungsmethode"), whose "goal" is the Golden Age of direct experiential knowledge. He is speaking here of a method and process of knowledge that transcendentally approaches the absolute ideal of the Golden Age. In his open method, the final goal is indeed total experiential knowledge, but the method of attaining this goal is a process of modifying and improving experiential forms of knowledge. Inquiry is carried out in the continual process and interaction of the "Experimentalmethode" and the "Beobachtungsmethode". As part of a form of inquiry, i.e. a process, both the "Experimentalmethode" and the "Beobachtungsmethode" are tools for the inquirer, enabling him a "sichern Progressus und Regressus" (*N*, 3, 123) during his investigations. The process of inquiry should be, as Novalis says, implying that the process should be conducted in the spirit of a piecemeal, but, none the less, progressive approach, "Schritt für Schritt entwickelnd (*N*, 3, 600). Novalis's open form of inquiry emphasizes above all the experiential processes of knowledge, and his concerns are with a practice-oriented concept of knowledge. This means not only that Novalis elevates broad areas of knowledge into a method using concrete induction (because of his broad definition of what can be considered to be experiential knowledge), but also that, because he is practice-oriented, the actual processes of discovery, as mentioned, are seen as a valid part of knowledge.

### *1.3. Herder's* Plastik *and the aesthetics of knowledge formation.*

An important influence on Novalis's experiential notion of knowledge was Herder. The source for Novalis's concept of the "Plastisirungsmethode" is Herder's essay *Plastik* (*52*), which Novalis directly comments upon at the end of September or beginning of October in 1798 (at the same time as his essay on Goethe). The relevance of Herder's *Plastik* is important as an example of a contemporary thinker who afforded a sensual-imaginative approach to knowledge. As already mentioned, Wilkinson and Willoughby have shown how Herder argues for the primacy of "Gefühl" over sight, and in doing so plays upon the two meanings of "Gefühl", that (literally) of "the senses", and that of an "inner sense" (*294*, 34). This distinction is crucial to Novalis, who very like Herder, believed in the primacy of the inner sense of the imagination as the tool through which man acquired knowledge. In the remark directly preceding a jotting from Herder's *Plastik*, Novalis notes how the senses are linked together by the creative imagination, and how that affords the primary sense of perception:

> Alles Sichtbare haftet am Unsichtbaren - Das Hörbare am Unhörbaren - Das Fühlbare am Unfühlbaren. Vielleicht das Denkbare am Undenckbaren -.
> Das Fernrohr ist ein *künstliches, unsichtbares Organ./Gefäß./*
> Die Einbildungskraft ist der wunderbare Sinn, der uns alle Sinne *ersetzen* kann - und der so schon in unsrer Willkühr steht. Wenn die äußern Sinne ganz unter mechanischen Gesetzen zu stehn scheinen - so ist die Einbildungskraft offenbar nicht an die Gegenwart und Berührung äußrer Reitze gebunden (*N*, 2, 650).

The sense of the "imagination" clearly owes much to Hemsterhuis's Neoplatonic stance to knowledge. The "imagination" here is not just a form of "fantasy", but a virtue (i.e. a power) which can cross the boundary between the visible and the invisible, and mediate between the two; because of its dual aspect, it is intimately connected to the ability to "plasticize". The notion of "Plastisirung" itself implies a "feeling" for "ideas", i.e. a non-conceptual approach to the understanding of ideas, and this is how man comes to understand the world, for the other senses are really mechanical like the telescope. In the annotation from Herder's *Plastik*, which directly follows the remark above on the imagination, Novalis notes down the passage on the blind mathematician Saunderson who, on regaining his sight, had to relearn to "see" the world again, translating his previous perception of the world through touch into the "language" of sight:

> Herders Plastik. pag.7. Man lehrte den Blindgebohrnen und Sehendgewordenen sein Gefühl sichtlich erkennen - Er vergaß oft die Bedeutungen der Symbole des Gefühls - bis sein Auge Fertigkeit erhielt *Figuren des Raums* und Farbenbilder , als *Buchstaben voriger Körpergefühle* anzusehen, sie mit diesen schnell zusammenzuhalten und die Gegenstände um sich zu lesen (*N*, 2, 650).

This example, amongst others, meant to many and to Novalis as well, that man did not simply "see" the world, but first had to interpret the world through the creative imagination. As Wilkinson and Willoughby have shown, Goethe, too, learnt this important lesson from Herder: it had a huge influence on Goethe's aesthetics and his whole notion of knowledge. Crucial for this approach is Herder's claim towards the end of his *Plastik*: it is a "Metaphysisch- und Physisch erwiesener Satz, *daß nur körperliches Gefühl uns Formen gebe*" (*52*, 71). Herder views all forms of mental activities in terms of sense perception, aesthetics and practical knowledge. Herder states here how knowledge has to be treated in a phenomenal sense, and indeed in an organic sense as an entity, or rather entities, since each sphere of knowledge has its own particular phenomenal form. The painter works with different experiential material or mediums to the writer, although they may indeed be trying to convey the same thing or experience. The point being made is that in every area of knowledge, before one executes an idea, a strong practical awareness of one's tools has to be attained. The implications for the writer are that the poet is not dealing with plain referential words; instead the poet learns to treat words as phenomena in their own right - this implies, for instance, that a whole group of words may contribute to the meaning of a text just as much as the individual semantics of the words. In this sense, the tenet of *Plastik* is the literal shaping of language en masse, as a sculptor does his stone.

The use of "die Plastisirungsmethode" for a general programme of knowledge is just this way of treating knowledge concretely. Inquiry is an open-ended entity for Novalis, and Nature, like the sculptor's raw stone, is the vast, open-ended mass of material man has to acquire a practical knowledge of in order to build up knowledge and further inquiry. In his "Plastisirungsmethode" Novalis argues that a concrete use of ideas and experiential, practice-oriented forms of knowing have to be maintained and upheld, to balance the analytical processes of the "Beobachtungsmethode". One is reminded here that Novalis's notion that the inquirer should have a "Gefühl" (*N*, 3, 256) for, or love of, Nature (*N*, 3, 179), does not necessarily imply rapture; rather "Gefühl" and "Liebe" are part of a carefully balanced procedure of inquiry that attempts to keep the scientist as close to the phenomena as possible. "Gefühl" and "Liebe" are part of Novalis's broad notion of experiential knowledge; in Herder's meaning of the "inner sense" they are closely connected to the concrete notions arising out of man's practical knowledge of Nature, connected to what man has experienced within himself and to what he has experienced of the outside world.

### *1.4. Goethe's "activer Empirismus". Aesthetics of "experiment" and "Formel".*

It is of interest to note that in 1792, after the "lesson" he had learnt from Herder in the preceding years, Goethe wrote his essay *Der Versuch als Vermittler von Objekt und Subjekt* (*41*), where something of the views from Herder's *Plastik* most probably remain. Goethe's empirical stance naturally leads him to argue for inductive experimentation in the sciences, and the accumulation and use of experiments in building theories, as opposed to pinning down a theory to a particular experiment or using the hypothetico-deductive method. As Goethe remarks, a particular experiment is the outcome of many other experiments, and, in fact, more often than not belongs to a group of experiments. In short, the experimenter has to work his way into a field, and have experienced many cases, before postulating a theory:

> So schätzbar aber auch ein jeder Versuch einzeln betrachtet sein mag, so erhält er doch nur seinen Wert durch Vereinigung und Verbindung mit andern. Aber eben zwei Versuche, die miteinander einige Ähnlichkeit haben, zu vereinigen und zu verbinden, gehört mehr strenge und Aufmerksamkeit, als selbst scharfe Beobachter oft von sich gefordert haben. Es können zwei Phänomene miteinander verwandt sein, aber doch lange nicht so nah, als wir glauben. Zwei Versuche können scheinen, auseinander zu folgen, wenn zwischen ihnen noch eine große Reihe stehen müßte, um sie in eine recht natürliche Verbindung zu bringen (*41*, 9).

This recalls Herder's thesis in his *Plastik*, where he argues against the too swift gaining of knowledge by the eye, and instead for the gradual feel and inner knowledge of an object. There are similarities between Herder's notion of perception and the issues surrounding practical knowledge and scientific productivity. The use of the inner senses and the tactile senses does not in any way mean leaving inquiry to "feeling" alone, for, as Goethe's remarks suggest, the procedure of acquiring an intimate knowledge of a particular topic requires strict controls and alertness to the procedures being undertaken and a thorough experience of the field.

The link between Herder, Goethe and Novalis is, in terms of their general attitude towards knowledge formation, particularly strong. The tenets of Herder's *Plastik* may not account for all the similarities, but the notions of productivity arising from his *Plastik* do find significant reverberations in Novalis's essay *Über Goethe* written around the same time as his notes on Herder and his *Kant-Studien*, that is nine months after his arrival at the Freiberger Bergakademie.[6] In this essay Novalis speaks of Goethe's stance to knowledge in general, and treats both scientific and literary issues. It is especially the issues concerning the aesthetics of scientific productivity and the rhetoric of "experiment" that will be discussed, since that is what is at stake here. Novalis had knowledge of much of Goethe's scientific works, specifically *Beiträge zur Optik*, *Die Metamorphose der Pflanzen* and *Die Metamorphose der Insekten*, and clearly held them in great esteem, particularly for the reason that Goethe was an artist setting a paradigm for inquiry itself:

Seine Betrachtungen des Lichts, der Verwandlung der Pflanzen und der Insecten sind Bestätigungen und zugleich die überzeugendsten Beweise, daß auch der vollkommne Lehrvortrag in das Gebiet des Künstlers gehört (*N* ,2, 640).

The imaginative quality here praised by Novalis would appear to be a form of "Plastisirung". Goethe's method of (re)-creating a "concrete idea" of the phenomena in his work provides a model for what Novalis also demands. He remarks later on, sometime between December 1798 and March 1799 in *Das allgemeine Brouillon*, that Goethe should be the new high priest of the ancient tradition of "holy" physics:

Göthe soll der Liturg dieser Physik werden (*N*, 3, 469).

What Novalis means by "holy" physics and by Goethe's role as an artist contributing to science is soon made apparent. To Novalis, Goethe was not an idealist, nor an empiricist per se; instead, in his works he espoused an "activen Empirismus" (*N*, 2, 641). It is due to this form of knowledge, where Goethe attempts to unite the processes of the natural world and human thought, that he is likened to a "holy physicist". Novalis had observed that Goethe was not merely listing statements about nature in his scientific works, or in his literary works merely recounting experience, but instead, in re-experiencing the world for himself, and translating these experiences into the appropriate scientific or literary mediums, he had created forms of writing that mediated between experience and theory, that were examples of concrete thought. The tradition of "holy" physics to which Novalis refers, and in which he sees Goethe acting a major role, is indeed the tradition into which his own programme of experiential-oriented knowledge fits, for Novalis's programme, in its various forms of "phenomenal" calculus or "Combinatorik", i.e. in its mediation between theory and phenomena in concrete theorizing, is very similar to Goethe's ideal empiricism which accounts for aesthetics in scientific productivity.[7]

To describe Goethe's works, Novalis recalls the Fichtian notion of the fundamental phenomenon or activity of knowledge:

Bey ihm ist alles That - wie bey andren alles Tendenz nur ist. Er macht wircklich etwas, während andre nur etwas möglich - oder nothwendig machen. Nothwendige und mögliche Schöpfer sind wir alle - aber wie wenig Wirckliche. Der Philosoph der Schule würde dies vielleicht activen Empirismus nennen (*N*, 2, 641).

With acute precision, Novalis focuses on "die Tat" as the central category of Goethe's thought,[8] and finds a term for Goethe's method, "active empiricism", which is no less astute than the celebrated one found by Siedenroth and praised by Goethe himself, that his "Denkvermögen gegenständlich tätig sei" (*38*, 13, 37). Both Novalis's and Siedenroth's terms remind one of the tenets of Herder's *Plastik*, and a further comment of Novalis's confirms this parallel. For Novalis says how Goethe's scientific method is comparable to that of the artist when contemplating the classical world: that is, the classical world or Nature first has to be re-experienced, or in Novalis's terms, "plastisirt" into concrete notions, in order to be understood and, importantly, also to be conveyed, so that others too can have a "Gefühl" for the subject:

Hier kommt es darauf an, ob man die Natur, wie ein Künstler die Antike, betrachtet - denn ist die Natur etwas anders, als eine lebende Antike. Natur und Natureinsicht entstehn zugleich, wie Antike und Antikenkenntniß; denn man irrt sehr, wenn man glaubt, daß es Antiken giebt. Erst jezt fängt die Antike an zu entstehen. Sie wird unter den Augen und der Seele des Künstlers. Die Reste des Alterthums sind nur die specifischen Reitze zur Bildung der Antike. Nicht mit Händen wird die Antike gemacht. Der Geist bringt sie durch das Auge hervor - und der gehaune Stein ist nur der Körper, der erst durch sie Bedeutung erhält, und zur Erscheinung derselben wird (*N*, 2, 640).

This notion of re-experiencing an object, as an example of "Plastisirung" and the "Experimentalmethode" is the key meaning of what, in postmodernist terminology, would perhaps be called Novalis's "rhetoric of experiment", and also the key sense of his notion of experiential knowledge since it points to experiential reflectivity.

Central to Goethe's form of scientific productivity is what Novalis describes as Goethe's particular form of abstraction, for Goethe always manages to keep hold of the phenomena:

Er abstrahirt mit einer seltnen Genauigkeit, aber nie ohne das Object zugleich zu construiren, dem die Abstraction entspricht (*N*, 2, 641).

Clearly, in Novalis's view, Goethe always provided theory with a concrete form. Novalis goes on, too, to speak of Goethe as a practical philosopher. This is helpful in defining the term "active empiricism", since the distinction is made between conceptual thought and a practice-oriented concrete form of theory, which is "angewandt", not just idealism, but theory put to use, and into action:

Dies [*Goethe's abstracting*] ist nichts als angewandte Philosophie - und so fänden wir ihn am Ende zu unserm nicht geringen Erstaunen auch als anwendenden, practischen Philosophen, wie denn jeder ächte Künstler von jeher nichts anders war (*N*, 2, 641).

Although Novalis would not have read Goethe's *Der Versuch als Vermittler von Objekt und Subjekt*, since it was first published in 1823, there are several parallels to Novalis's notion of experiential knowledge and scientific productivity. Firstly, Goethe stresses the need to return to experience as far as is possible. Knowledge is approached above all from experience and not by the testing of a favoured theory:

Da alles in der Natur, besonders aber die allgemeinern Kräfte und Elemente in einer ewigen Wirkung und Gegenwirkung sind, so kann man von einem jeden Phänomene sagen, daß es mit unzähligen andern in Verbindung stehe, wie wir von einem frei schwebenden leuchtenden Punkte sagen, daß er seine Strahlen nach allen Seiten aussende. Haben wir also einen solchen Versuch gefaßt, eine solche Erfahrung gemacht, so können wir nicht sorgfältig genug untersuchen, was *unmittelbar* an ihn grenzt, was *zunächst* auf ihn folgt. Dieses ist's, worauf wir mehr zu sehen haben als auf das, was sich auf ihn *bezieht*. *Die Vermannichfaltigung eines jeden einzelnen Versuches* ist also die eigentliche Pflicht eines Naturforschers (*41*, 12-13).

This theory is very similar to Novalis's requirement that the scientist works from experience outwards, from a particular phenomenon, in a form of "calculus". The gradual steps envisaged by Goethe correspond to Novalis's progressive "calculus", and his form of "Combinatorik". Just as Goethe proceeds from phenomena, Novalis believes that experiments and the experiences themselves could improve a starting-point for a more encyclopaedic "Combinatorik". The broader the base of data in a "Calcül", the more comprehensive the theory will be. Goethe stresses the need for clear connexions, Novalis emphasizes the experiential base:

Man geht mit den Erfahrungen und Experimenten noch viel zu sorglos um - Man versteht sie nicht zu benutzen - Man betrachtet zu wenig die Erfahrungen - als Data zur Auflösung und mannichfaltigen Combinationen zum Calcül - Man überlegt die Erfahrungen, in Beziehung auf Schlüsse, nicht sorgfältig genug - Man nimmt nicht jede Erfahrung, als Function und Glied einer Reihe an - man ordnet - vergleicht - und simplificirt die Erfahrungen nicht genug - man prüft einen Gegenstand nicht mit allen *Reagentien* - man vergleicht ihn nicht fleißig - und mannichfach genug (*N*, 3, 427).

Interestingly, both Goethe and Novalis stress the "manifold" character of the necessary phenomena, and the need for "Vermannichfaltigung"; the essential difference between them here lies, however, in Novalis's use of the mathematical term "Calcül" and the Neoplatonic and Lullian idea of "Combinatorik"; both of which are more abstract than Goethe's terms. Yet, with that important distinction, Novalis is exceedingly close to Goethe.

Moreover, Goethe's method of induction, so apparent in the way he describes and lays down his scientific findings, and in the way he moves from one phenomenon to another, is precisely the sort of method Novalis refers to himself in the following remark of 1799:

Ein Phaenomèn muß nothwendig zu andern Phaenomènen führen, wie Ein Experiment zu mehreren Experimenten. Die Natur ist ein *Ganzes* - worinn jeder Theil an sich nie ganz verstanden werden kann. Der ächte Naturforscher geht von irgend einem Puncte aus und verfolgt seinen Weg Schritt vor Schritt in die Unermeßlichkeit hinein mit sorgfältiger Verknüpfung und Aneinanderreihung der einzelnen Thatsachen (*N*, 3, 603).

This remark of Novalis's ought to be read both in view of his notion of a "phenomenal" calculus and in the light of Goethe's notion of induction, which, as has been discussed in the introduction, contains many aspects of Novalis's idea of calculus. Novalis's "experiment" is not exactly the same as Goethe's in his *Versuch*, partly because Novalis stresses the notion of calculus. The idea of "experiment" takes on the meaning of testing, and relies on concrete thought or notation (as desired by Goethe); however, it also refers more to the art of inventing, as found in the tradition of Combinatorik. In the passage under discussion, Novalis advocates a form of "active" empiricism, and imbues it with the notion of a "phenomenal" calculus. The activity of experimentation itself and the actual handling of phenomena, where one experience naturally leads to another, should imitate Nature and lead to a more cohesive picture of Nature. The sort of calculus Novalis refers to, and also what he would have seen in Goethe's scientific works, is a calculus of activity and of literal experimentation, where the inquirer is so close to the phenomena both literally and in his mind, that he theorizes concretely, and in this sense "calculates", using "Gefühl" and combinations of images in the mind. If this is not the same as Goethe's method, Novalis yet, like Goethe, stresses how little man can conceive of the complexities and combinations within Nature herself ("die Natur ist ein *Ganzes*"): hence inquiry must be progressive in an inductive manner, and avoid the pitfalls of over hasty-hypothesizing.

Novalis's important remark shows him moving towards Goethe's stance on inquiry; but equally, Goethe himself tends towards Novalis's idea of a "phenomenal" calculus in some comments he makes in his *Versuch* regarding the link between experimental method and the mathematical method. Although Goethe avoids the term "calculus", he seems, like Novalis, to be alluding to that part of mathematics. Probably more emphatically than Novalis, however, Goethe discusses mathematics more strictly within the realm of induction. A key part of Goethe's notion of scientific productivity is the idea of an analogy between a higher inductive statement and the statements, experiments and experiential knowledge it is made up of. In his *Der Versuch als Vermittler von Objekt und Subjekt*, when describing his method in relation to his optical works, Goethe observes:

Ich habe in den zwei ersten Stücken meiner optischen Beiträge eine solche Reihe von Versuchen aufzustellen gesucht, die zunächst aneinander grenzen und sich unmittelbar berühren, ja, wenn man sie alle genau kennt und übersieht, gleichsam nur *einen* Versuch ausmachen, nur *eine* Erfahrung unter den mannichfaltigsten Ansichten darstellen.

Eine solche Erfahrung, die aus mehreren andern besteht, ist offenbar von einer *höhern* Art. Sie stellt die Formel vor, unter welcher unzählige einzelne Rechnungsexempel ausgedrückt werden. Auf solche Erfahrungen der höhern Art loszuarbeiten halt ich für höchste Pflicht des Naturforschers, und dahin weist uns das Exempel der vorzüglichsten Männer, die in diesem Fache gearbeitet haben (*41*, 13).

This passage fully reveals the reflectivity of Goethe's approach to scientific methodology; far removed from simple empiricism, this "symbolic empiricism" leads directly from the phenomena to higher-order statements by what might be called inductive construction. This approach may be compared to that offered by Novalis when the latter says that the *explanation* must form an analogy with the phenomena, just as much as the individual experiments themselves must do so:

Wenn der Satz, oder die Verhältnisse - der Gegenst[and] oder der Begriff - richtig gewählt sind - wircklich Eins sind - so muß auch die Demonstration und Auflösung - das Experiment und die Erklärung - *durchaus* übereinkommen.

Wie das Experiment die bloße Erweiterung - Zertheilung - *Vermannichfaltigung* - *Verstärckung* des Gegenstandes ist, so ist die Erklärung dasselbe vom Satze - Hier gilt also der Satz:

Was vom *niedern Grade* gilt, muß auch vom *höhern Grade* gelten. Was im niedern Grade *durchaus eins* ist, muß auch im *höhern Grade* durchaus *Eins seyn* (*N*, 3, 353).

Novalis, like Goethe, sees the use of constructive analogizing as a key to inquiry: the closer the inquirer is to the phenomena the greater his "Gefühl", and hence the greater his ability to form analogies between theory and phenomena. Consequently, the closer the inquirer will be to forming theory that is intertwined with phenomena, where he can then maintain that "das Experiment und die Erklärung - *durchaus übereinkommen*".

Goethe's dictum that the search for such higher experiences is the task of the scientist also relates to what Novalis believed was part of the Baconian method, namely the need to find an inner logic or concrete notation that would serve as an experiential tool with which one could carry out further research. Higher experiences, which encompass many other experiences, are a form of theory which has got so close to the phenomena that it is symbolic of certain natural processes.

Inductive generalizations can be seen as idealizations of phenomena. In his comment on Bacon, Novalis refers to the calculus of mathematics:

Die combinat[orische] Analysis der Physik wäre die indirecte Erfindungskunst, die Baco gesucht hat (*N*, 3, 128).

Clearly, Bacon could not have been thinking towards a mathematical calculus in particular, but was dwelling upon a general "Erfindungskunst" or symbolic logic, and similarly, Novalis, although here referring to mathematics, usually speaks of his own broader notion of "calculus", which is analogous to Bacon's search for a concrete notation of "real characters". In scientific productivity, and in its greater sense of natural philosophical productivity, which is to Novalis a form of "Calcül", good generalizations become part of an inner logic that is close to phenomena, and can be of predictive value ("die indirecte Erfindungskunst"). Here the meaning of Novalis's calculus again becomes clear: he argues for a form of "phenomenal" calculus, consisting not of strict mathematical formulas, but of experiential formulas. It is at this point that Goethe's and Novalis's references to mathematical method cross over. In his *Versuch* Goethe speaks of the higher experience of his inductive procedure as a "Formel" ("Eine solche Erfahrung, die aus mehreren andern besteht, ist offenbar von einer *höhern Art*. Sie stellt die Formel vor, unter welcher unzählige einzelne Rechnungsexempel ausgedrückt werden" (41, 13)). Goethe is referring to a symbolic phenomenal whole that unifies the series of experiments and the phenomena under investigation. The experiential and symbolic "Formel" can be interpreted as acting as the higher function for the series of experiments. In this blend of aesthetics and science, Goethe is himself undertaking a "phenomenal calculus". This is the meaning of what today, in postmodernist terminology, would perhaps be called Novalis's and Goethe's "rhetoric of experiment". Aesthetics and scientific method are so intimately linked that this "rhetoric of experiment" is best called natural philosophical productivity.[9] One can call this concrete notation a variety of symbolic logic, or one can more pragmatically say that this notion of "experimentation" implies the use of what we would now call models of phenomena, which, for Novalis and Goethe, in the experimental process of inquiry itself, mediate between phenomena and theory.

Following up on this point of the experimental process of scientific productivity, also implied in Goethe's method are the hidden implications of good inductive descriptions: they are not just statements but part of a discovery process, or what Novalis calls the "history of discoveries". The actual processes of creative discovery are visible in the description of the experiments. This means that the scientist does not start off with a theory he wants to prove in hypothetico-deductive fashion, instead, in terms of the aesthetics of scientific productivity, the inquirer works towards a theory, speaking as it were the language of the phenomena and the experimental apparatus. This is also part of the meaning of "Gefühl" for the scientist in Novalis's view. The actual process means taking particular phenomena ("gutgeordnete Beschreibungsreihe") as concrete theory, as models with which one can work:

> Geschichte der Versuche Versuche zu stande zu bringen. Die Idee eines Versuchs zu realisiren - gutgeordnete Beschreibungsreihe der Experimentalversuche sind wohl ebenfalls Synonymen d[er] phil[osophischen] Geschichte (*N*, 3, 439).

Here, as well, Novalis is speaking not of theory, but instead elevates discovery processes to the status of philosophy, and not just "scientific" discovery processes per se, but above all forms of productivity.[10] Productivity in general, i.e. the formation of knowledge, is an "experimental" discovery processes, in which an inductive "calculus" takes place. Novalis's starting point for all inquiry is never theory, but a larger view of experience itself. This corresponds essentially with the breadth in which Goethe himself approached inquiry: one only has to think, for example, of the manifold ways in which Goethe inquired into the phenomenon of light in his *Farbenlehre*. Further, as with Novalis, for Goethe the notion of "experiment" expresses both a strong epistemological element in his thought and also a fundamental attitude to knowledge, that takes accounts of the essential experiential and experimental nature of life and inquiry.

### *1.5. Schelling: natural philosophical productivity.*

Ample space has been given in the introduction to the Schelling's thought. Novalis and Schelling were in many ways concerned with the same issues: the notions of productivity in the light of natural philosophy. Novalis does, however, at times take issue with Schelling, as for example over what Novalis sees as the latter's dualism in his *Von der Weltseele*. This emerges in the following remark:

Die Wissenschaft fängt nicht mit einem Antinom - Binom - sondern mit einem Infinitom an (*N*, 3, 432).

This comment can be seen to attack concepts like Schelling's mediation of "Geist" and "Natur".

At the same time, however, Novalis recognizes that Schelling does account for individual, generative organic form: "Schellings Individualisierungs, besser Vermannichfaltigungstrieb der Natur" (*N*, 3, 430). These two comments of Novalis's highlight the fact that Schelling and Novalis were working on the same project, that of natural philosophy, but in different ways. Novalis never attempted to write systematic works such as Schelling's, and in this sense he had greater freedom of thought. Novalis could thus criticize Schelling's presentation of dualistic forces, while also observing that Schelling was, in other aspects of his work, arguing quite in his own sense, and indeed that he was in general on what Novalis saw as the correct path: Schelling was a thinker "der das Höchste ahndet" (*N*, 4, 261). However, the major difference, as has been pointed out in the introduction, is that Novalis is far more concerned with scientific productivity than Schelling. Clearly, Schelling's notions of dynamic natural forces, just as Ritter's notions of galvanism, would have found Novalis's approval. Most important is the fact that at the most fundamental level of their thought, at the level of natural philosophical productivity, Novalis and Schelling are in accord. It is the aesthetic element in natural philosophical productivity which leads them both to speak of the term "intellektuale Anschauung" (*N*, 3, 440). Schelling's postulated natural forces are, as remarked, products of natural philosophical productivity and are akin to Novalis's notion of "wircksame Begriffe".

*1.6. Fichte's "Thathandlung" and Novalis's shift to transreflexivity.*

Novalis had studied Fichte closely. Most important to Novalis was Fichte's notion that knowledge was an activity. Fichte's concept of "Tathandlung" refers to the initial free act of self-positing that precedes all thought. Any form of consciousness is preceded by this primary act of the self, and our knowledge of objects outside ourselves is dependant upon this. Thus, too, subject and object are always bonded together in Fichte's "Ich", as an act of the consciousness, or in Fichte's words:

Das Ich sezt ursprünglich schlechthin sein eigenes Seyn (*28*, I, 2, 261).

This is crucial to Novalis's own views on knowledge, since Fichte's "Tathandlung" implied that the primary act of the "Ich" was free. This accorded with Novalis's notion of the creative imagination. Novalis readily wrote down:

Warum die erste Handlung eine freye Handlung seyn muß - weil sie keine andre voraussezt - Sie ist, weil sie ist, nicht weil eine andre ist. Folglich ist die Bestimmung des Ich, als Ich, frey (*N*, 2, 105).

Fichte's law of the sentence of identity, A = A, thus gave to Novalis a sense that knowledge was not formal or conceptual, but an activity, part of Being itself. Frank has shown the fundamental difference between Novalis and Fichte at the level of their philosophies of consciousness. Fichte argues that the "Ich" posits a "Nicht-Ich" against itself and that the absolute is present in the intellectual intuition. Novalis, on the other hand, sees the absolute represented indirectly (transcendentally) in the "intellektuale Anschauung" (*N*, 2, 119). Instead of positing a "Nicht-Ich" against the "Ich", Novalis sees subject and object both in the "Ich" as a process of consciousness where "Gefühl" and "Reflexion" or "Urhandlung" and "intellektuale Anschauung" interact (*N*, 2, 125; *315*, 76; *354*, 116-117). This fundamental pattern of Novalis's thought - the transreflexivity of the subject - is described in Frank's article on Novalis's notion of "Ordo inversus". This figure of thought in the idea of "Ordo inversus" has many parallels in Novalis's thought, such as his notion of "Hin und Her", or, indeed the interaction of the "Beobachtungsmethode" and the "Experimentalmethode" (*N*, 3, 123) (see below, p.374).

In other aspects, as already discussed, Fichte's general direction of thought appealed to Novalis greatly. Fichte's disparagement of formal thought in his notion of "experiment" bears considerable similarity to Novalis's notion of induction and "experiment".

However, although Fichte by no means negates the outside world, he did not attempt to account for Nature in terms of empirical detail, and this, when Novalis arrived at Freiberg, was soon to become a major factor in his emancipation from Fichte. Lauth describes how Fichte had, throughout his writings, made references to a "general" natural philosophy ("allgemeine Naturphilosophie"), but that Fichte never bound in the empirical sciences to any great extent into his thought. The sort of material Novalis was interested in, such as excitability, galvanism or the pneumatic debate, found almost no resonance in Fichte's works (*232*, xiv-xv). Novalis never gives up Fichte entirely, and the *Das allgemeine Brouillon* has many references to Fichte, but by now Novalis was clearly searching for a less purely philosophical model of knowledge, and instead for a model that would account more for his empirical interests.

*1.7. Plotinos: "thätiger Empirismus" and pantheistic transreflexivity.*

A remark towards the end of *Das allgemeine Brouillon* points to Novalis's differences with Fichte and at the same time to the model he had found:

Die Hypostase versteht Fichte nicht - und darum fehlt ihm die andre Hälfte des schaffenden Geistes. Ohne *Ekstase* - fesselndes, alles ersetzendes B[ewußt]S[eyn] - ist es mit der ganzen Philosophie nicht weit her (*N*, 3, 465).

Novalis here criticizes the aridity of excessively sober philosophical thought, and emphasizes both the need for an ecstatic attitude to knowledge, such as he would have been aware of in Pietism, and also the necessity to view knowledge phenomenally; that is, not just concretely, but also as a phenomenon within Nature, as one of the hypostases in the hierarchy of Being. This marks the limit of his proximity to Fichte, and points to a more fundamental influence on his later thought.

Specifically, the terms "Hypostase" and "Ekstase" explicitly refer to Plotinos, and it is to Plotinos that one must turn for a full understanding of Novalis's mature thought on knowledge (as, incidentally, for an appreciation of Goethe's, too). Plotinos holds that knowledge is phenomenal and part of the Chain of Being. Plotinos's hypostases allow for ideas as a particular realm of Nature, and this was the sort of model of knowledge that Novalis was seeking, where both the subject and the object were accounted for in the whole organism of Nature. From his reading of Dieterich Tiedemann's *Geist der spekulativen Philosophie* (*117*) between December 1798 and January 22 1799, Novalis learnt of Plotinos's notion that the world soul was made up of light, and in this way that the ideal or knowledge had physical form, as Tiedemann comments:

Dennoch behauptet Plotin, der Weltseele Substanz sey Licht, wie die der Materie, Schatten und Finsterniß (*117*, 3, 309).

Novalis takes this notion on and applies it to philosophy in general. Using Plotinos's notion of the physical nature of knowledge, Novalis refers to "Ekstase" as a phenomenon:

Ekstase - Innres Lichtphaenomèn = intellectualer Anschauung (*N*, 3, 440).

Novalis's pulls Plotinos into heart of the debate over German Idealism. His notion that the "intellectuale Anschauung" is light itself shows how Novalis's views on aesthetics and practical knowledge are, quite literally, concerned with natural philosophical productivity: light is linked directly to man's consciousness of nature. The alleged concreteness of ecstatic knowledge provides Novalis, in Plotinos's sense, with a model for a hierarchy of Being that accounts for thought. Indeed, Tiedemann stresses Plotinos's ecstatic path to knowledge of the Godhead, and that, in Plotinos's view, knowledge and God are light:

Man erblickt nichts als das herrlichste Licht, weil in Gott nichts ist als Licht (*117*, 3, 281).

Although Novalis learnt of Plotinos through Tiedemann, who was very much an enlightenment thinker and "kritisch-rational", as Mähl describes him (*N*, 3, 981), this had little filtering effect on Novalis. Novalis read through Tiedemann's censures of Plotinos, to come to his own highly positive view of him.[11] Indeed, his reading of Plotinos seemed to congeal and bring to a head much of his thought in *Das allgemeine Brouillon*. This is undoubtedly a major threshold of Novalis's development. As with his *Kant-Studien*, it is a key point of reflection. Plotinos put modern thinkers into perspective for Novalis, in that he provides a general model into which they could be assimilated as part of a continuum of inquiry. This is revealed in some key remarks of Novalis's which will now be dealt with.

Plotinos, importantly, provided Novalis with a physical and metaphysical base for knowledge, that of "Sympathie". Even though Novalis only read of Plotinos through Tiedemann, his reading substantiated the ideas he had already obtained from Hemsterhuis, and lead him to develop further his Neoplatonic ideas. With "Sympathie" in mind, Novalis refers to Plotinos's concept of emanations when describing the processes of thought:

Sonderbares Accompagnement der Verstandesfantasieen - des abstracten Spiels - mit *innern* SinnenFantasieen und Bilderspiel - Begleitende Symbolisation, oder *Schematism*. Emanat[ions] Lehre etc. (*N*, 3, 441).

This remark assumes the various forms and stages of the Plotinian emanations or hypostases, how there is an analogy between them, and how this phenomenon of analogy is the driving force behind them all.[12] Novalis here envisages a parallelism between various inner processes ("Verstandesfantasieen" and "SinnenFantasieen") and subsumes them both under representation in general ("Schematism"), which itself belongs to a wider process ("Emanat[ion]").

In another remark, Novalis links the notion of the creative force of "Sympathie" directly to Plotinos and "experimentation":

> Plotin war schon in Betreff der meisten Resultate - kritischer Idealist und Realist./Fichtes und Kants Methode ist noch nicht vollst[ändig] und genau genug dargestellt. Beyde wissen noch nicht mit Leichtigkeit und Mannichfaltigkeit zu experimentiren - überhaupt nicht *poëtisch* - Alles ist so steif, so ängstlich noch.
> Die freye *Generationsmethode* d[er] Wahrheit kann noch sehr erweitert und simplificirt - überhaupt verbessert werden. Da ist nun diese ächte Experimentirkunst - Die *Wissenschaft* des *thätigen Empirismus* (*N*, 3, 445).

This is a fundamental statement of Plotinos's importance for Novalis, which leads to the centre of his project. It clearly confirms the way in which his reading of the Neoplatonist relativized his understanding of modern philosophy. The emphasis on "thätigen Empirismus" naturally links back to his comments on Goethe's "activen Empirismus". It refers to a form of empiricism and "experimentation" with concrete notions, and to the mediation of subject and object. Through his reading of Tiedemann, Novalis perceived Plotinos's philosophical method as a type of "active empiricism"; for Plotinos argued from the abstract to the concrete, providing abstractions with concrete metaphors and images. Tiedemann comments on Plotinos's form of philosophy:

> Er hilft sich hier, wie überall, mit Erschleichung, daß er nemlich dem Intellektuellen sinnliche Bilder und Begriffe heimlich unterlegt, und so mit seinen Lesern etwas vorgaukelt ... (*117*, 3, 321)

Although Tiedemann speaks critically of Plotinos's method, Novalis sees Plotinos's strength precisely in this disparaged philosophical method. What makes Plotinos's philosophical style even more attractive for Novalis is his pantheistic ontology. The link between Plotinos, Schelling and Novalis in terms of their notions of pantheism is strong. As already discussed, both Frank and Uerlings show how "Natur" and "Geist" for Novalis and Schelling are linked at various levels of consciousness (*170*, 105; *354*, 162-163). The interpenetration or transreflexivity of levels of knowledge and being in Novalis's and Schelling's notions has similarities with what Tiedemann calls the particular mixture in Plotinos's thought of "groben" and "feinen Spinozismus". "Grober Spinozismus" refers to the idea that matter evolves from and is part of God (*117*, 429). As mentioned, both Novalis and Schelling move away from the notion of the immanent absolute to the idea of the absolute's transcendence. "Feiner Spinozismus" refers to God as the starting point for all thought and to the use of the "inner sense":

Er [*Plotinos*] lehrt feinen Spinozismus, wenn er Gott zum logischen Subjekte aller in der Erfahrung vorkommenden Mannigfaltigkeiten macht, und aus Verstandesbgriffen alles sinnliche herleiten will ... Aus diesen feinen Spinozismus führt unausweichlich die Bemühung, aus bloßen Verstandesoperationen, und nach bloßen Begriffen des inneren Sinnes, alles zu erklären (*117*, 430).

In this way man employs the inner sense of the God in himself to come to know the world (*117*, 429). What annoys Tiedemann so greatly is what could be termed Plotinos's form of natural philosophical productivity, i.e. the "sinnliche Bilder und Begriffe" of the productive imagination which attempt to explain nature. This aspect of Plotinos's thought gives a further perspective to Novalis's idea of "experiment" and phenomenal calculus, as will be seen in the next section. Plotinos's particular form of pantheism would have struck an immediate chord with Novalis, for shortly before he began reading Plotinos, he had himself come to similar conclusions about the relationships between the soul of nature and its outer, man's soul and his outer, and how man can understand and sense nature:

Daß wir nur durch Gedanken das Innre und d[ie] Seele der Natur vernehmen können, wie wir nur d[urch] Sensationen das Äußre und d[en] Körper der Natur (*N*, 3, 429).

Like Plotinos, Novalis sees external nature with its own body and soul, humans with their body and soul, and the outer world in us in our thought ("daß es auch eine Außenwelt in uns giebt" (*N*, 3, 429). Here, in this transreflexivity, lies a pantheism which profoundly links the thought of Plotinos, Schelling and Novalis.

In calling Plotinos "kritischer Idealist und Realist", Novalis also uses Plotinos to view the philosophies of Kant and Fichte in a new perspective. Kant and Fichte both treat the experientiality of knowledge, but to Novalis both had not gone far enough. Within the bounds of their more sober philosophy they were not as poetical as Novalis would have wished, they were still "ängstlich". For Novalis, genuine critical philosophy lies in calling the specific areas of theoretical, aesthetic and practical knowledge into question and subsuming them all under natural philosophical productivity. In this sense, Novalis speaks for the need of treating knowledge in terms of an experiential whole ("Mannichfaltigkeit"), and for the need of an ease in moving between subjects ("Leichtigkeit"). In Plotinos's transreflexive model of knowledge the inquirer can move with ease between the inner and outer worlds, between subject and object. Novalis advocates a freer form of argumentation and knowledge formation than that of Kant and Fichte in his concept of concrete notation, which is symbolic ("poëtisch") in nature and feeds on a broad experiential base. As mentioned, Plotinos's freer form of philosophizing was most certainly made apparent in Tiedemann's commentaries, who often rebukes Plotinos as speculative and for his lack of formal philosophical style.[13]

Further, "Sympathie" is the driving force behind "die freye Generationsmethode der Wahrheit", for the concrete images used in Novalis's "Plastisirungsmethode" operate on the "Sympathie" between man's thought and phenomena. Through "Sympathie", knowledge can be "generated" as concrete thought in a method of discovery. The notion of "Generation" is also an allusion to contemporary excitability theory and the "Reproduktionskraft, and shows the way that Novalis views knowledge, like the organism, as an active, physical process. For Novalis, Plotinos has a deeper notion of concrete knowledge than Fichte, since he brings organization into play in the "generation" of knowledge through what Novalis interprets as the organizing force of "Sympathie". Through "Sympathie", Novalis is able to interpret knowledge in a concrete, phenomenal way, not just at one level such as espoused in Fichte's notion of "active" thought, but also at another level, as a phenomenon in the Chain of Being. In this way, Novalis's notion of "kritischer Idealist und Realist" implies an ontological link between the subject and the object, not just at the level of perception, but also at a material level.

Further remarks of Novalis substantiate this view of his relationship to Plotinos in terms of ontology and a transreflexive model of knowledge; they also show how

Novalis worked hard at assimilating Fichte into Plotinos's scheme of thought. Novalis places Plotinos at the top of his list of "holy physicists":

Fichte wird hiernach seine Freunde beschämen, und Hemsterhuis ahndete diesen heiligen Weg zur Physik deutlich genug. Auch im Spinotza lebt schon dieser göttliche Funken des Naturverstandes. Plotin betrat, vielleicht durch Platon erregt, zuerst mit ächtem Geiste das Heiligthum - und noch ist keiner nach ihm wieder so weit in demselben vorgedrungen.
In manchen ältern Schriften klopft ein geheimnißvoller Pulsschlag und bezeichnet die Berührungsstelle mit der unsichtbaren Welt - ein Lebendigwerden. Göthe soll der Liturg dieser Physik werden - er versteht vollkommen den Dienst im Tempel. Leibnitzens Theodicee ist immer ein herrlicher Versuch in diesem Felde gewesen. Etwas ähnliches wird die künftige Physik, aber freylich in einem höhern Style. Wenn man bisher in der sog[enannten] Physikotheologie nur statt Bewunderung ein ander Wort gesezt hätte (*N*, 3, 469).

In Novalis's view, Plotinos was the initiator of a long tradition that takes account of the physical nature of knowledge, as an activity and as part of Being, and thus of the link between man's consciousness and Nature. Characteristically, Novalis views Plotinos as a part of a tradition, each member of which has a contribution to make. Thus, for example, he links Fichte and Goethe to the Neoplatonist. Fichte, for his study of the subject, is also seen as a "holy physicist", and is drawn together with Plotinos. Elsewhere in *Das allgemeine Brouillon*, Novalis compares Fichte's philosophy (his "logisches Schema") to Plotinos's thought; what he calls Fichte's "Combinationen" (i.e. his method of working with terms and ideas, constantly moving around the same concepts) he sees as physically productive. They produce a "flame" within man, which may be compared to Plotinos's "inner light":

Fichte thut durch geschriebene Worte und Wortformeln - Combinationen - *innere Wunder* - ... Gegenseitig Bezognes simultanes *Sprechen* und *Denken* (thätiges Betrachten) thut Wunder - erzeugt eine Substanz (*Flamme*), die beydes, Sprechen und Denken harmonisch erregt - und bildet (*N*, 3, 443).

Novalis pursues the very concrete way in which Fichte's thought takes effect on the reader - what Novalis calls "holy physics" would today fall to psychology - and bases his argument partially on excitability theory ("erregt"); Neoplatonically, he envisages an active process dependent on "Sympathie", operating with

"Combinationen", which "physically" generates knowledge (as a "Flamme"). Through language, both speech and thought are shaped and advanced ("bildet").

In another remark, Novalis inserts the Fichtian notion of the "Ich" into a Neoplatonic scheme and exploits excitability theory, in a "pathology" of the formation of knowledge. In this case, he attempts to unite contemporary chemistry and pathology with both critical philosophy and Neoplatonism. The soul is related to oxygen; knowledge and metaphysics are thereby linked to matter, within what is presented as a pathological assessment of the Chain of Being. This technique is a form of "Combinatorik":

Über unser Ich - als der *Flamme* des Körpers in der *Seele*. Aehnlichkeit der Seele mit Oxigène. (Oxigène als Irritabilitaetspr[ocess].) (*N*, 3, 440).

Beginning with a modern, Fichtian "Ich", Novalis imbues it with a Neoplatonic "light"; he interprets the flame in terms of the modern French chemistry of Lavoisier, but goes beyond this by interpreting the chemistry in terms of excitability. By this active "Combinatorik" Novalis gives a more modern, concrete meaning to Plotinos.

There is, further, a possible allusion to Plotinos's concept of the "Einen", God, as the physical catalyst for thought:

Sollte Gott d[as] *Element* der Synthesis seyn - gleichsam das Oxigène dieser Operation. (Experimentiren in Gott - Theosophistereyen) Spinotzism - Emanationsystem (*N*, 3, 443).

This remark takes the argument one major step forward, to the Final Cause. God is subjected to a scientific interpretation as that which will feed combustion (oxygen). In brackets, Novalis names the whole nature of the enterprise: "Experimentiren in Gott". The comparison to Spinoza refers, as has been seen, to Plotinos's transreflexivity, whilst the final term places the whole procedure into the overarching structure of Plotinos's philosophy.

Novalis also draws further comparisons between Fichte and Plotinos: in his view there was as much occult "Sympathie" in Fichte's essential tenets as in Plotinos's, for Fichte's "Tathandlung" was itself based upon a fundamental "sympathy".

Accordingly, Novalis draws the two thinkers together in their concrete, experience-oriented methods: both operate symbolically using "Muster" to build models of the world (Plotinos employs his hypostases and emanations; Fichte uses his "logisches Schema"):

Das *logische Schema* der Wissenschaft hat Fichte gleichsam zum Muster einer realen Menschenkonstruction und Weltkonstruction gewählt. Seine Aehnlichkeit mit *Plotin* (*N*, 3, 443).

Novalis presumably recognized the similarities between Fichte's construction of the "Ich" and Plotinos's view that the actual creation of the world came about through "sympathy". For Plotinos's world began when the "One" reflected upon itself, and did this through "sympathy"; it thereby became aware of the "sympathy" between itself and its reflection on itself. So too did Fichte's "Ich" simply posit itself in a fundamental reflection, and become aware of itself. In reading Tiedemann, Novalis would have recognized these similarities, as Mähl points out. Mähl cites the following remark of Tiedemann's on Plotinos's thought:

Immaterielle Dinge, so bald sie gedacht werden, existiren sie auch, denn was der Verstand denkt, sezt er, und was er sezt, ist ... So bald der Verstand sich selbst denkt, denkt er sich existirend, und sieht dadurch das wahre Wesen. Er denkt sich aber auch als stets existirend, stets denkend, und sieht dadurch die Unveränderlichkeit. Er denkt sich endlich als von einem Gedanken zum andern gehend, und erblickt dadurch die Veränderung. Diese drey Dinge unterscheidet der Verstand von einander, sieht ihrer Verschiedenheit im wahren Wesen, und denkt dadurch die Verschiedenheit. Er denkt sie endlich als in Einem, als Eins, und erblickt dadurch die Einerleyheit ... (*117*, 3, 403-4; *N*, 3, 984).

Mähl adds:

Ähnlich hat Fichte in seiner Wissenschaftslehre von 1794/95 die drei logischen Gründsätze der Identität, des Gegensetzens und des Grundes aus den reinen Denkhandlungen des Ich entwickelt (*N*, 3, 984; *28*, I, 2, 255-282).

Although this is true, it is no less relevant from Novalis's viewpoint to speak of the similarities between Fichte and what Tiedemann says of Plotinos in terms of "Sympathie". For this process of creation envisaged in Fichte, and what Tiedemann remarks on Plotinos, is indeed the same as what Plotinos and Novalis regarded as a process of "Sympathie". It is also reasonable to assume that the idea of creation described to the hero in *Heinrich von Ofterdingen*, that is, how "durch wundervolle Sympathie die Welt entstanden sey" (*N*, 1, 220), was a view held by Novalis himself. This somewhat cryptic comment could equally be interpreted both in Fichtian terms of an action of the "Ich", or, less technically, in the sense that "love created the world". However, the informed reader will recognize how the statement is coloured and shaped by Novalis's mature philosophy as a whole. It needs to be interpreted in terms of his reading of Plotinos through Tiedemann, as well as in terms of his absorption of Hemsterhuis and Fichte. The statement thus embodies a quintessence of Novalis's reading, and, simultaneously, of his own thought.

*1.8. Plotins Physik, "experiment" and "phenomenal" calculus.*

Within the context of the remarks revolving around Plotinos, Novalis comments on the Schoolmen and how they differed in their formal approach to knowledge from Plotinos. They were, according to him, too abstract, and failed to turn their knowledge back into experience, or as Novalis puts it, to turn knowledge into a "*System*, oder *Reihengewebe*". Plotinos's philosophizing and Fichte's *Wissenschaftslehre* were, by contrast, to be read as the practical consequences of thought; hence they entailed an experiencing or phenomenalization of knowledge:

Die Scholastiker verwandelte[n] alle Dinge in abstracta - Schade, daß sie nicht, zugl[eich] in Beziehung auf diese Operation - die Entgegengesetze versuchten - und über dieses Verfahren *nachdachten*, oder *Schlüsse* daraus zogen.
(Das Nachdenken verwandelt alles in *System*, oder *Reihengewebe*.) (*N*, 3, 442).

The term "Reihengewebe" probably refers to the grand galvanic circuits of Nature. It is an idea taken from Ritter's notions of galvanism and organization (which so inspired Novalis) and lends a concrete, overarching context to the reflection.

Another remark on the Schoolmen in the same section of *Das allgemeine Brouillon* puts them in a different light. Indeed, Novalis sees them as being close to Plotinos. Novalis makes clear that he is talking of the Schoolmen in a general and positive sense this time, and talking of others who, in this positive sense, bear some similarities to the Schoolmen. This comment picks up on some key issues in the Neoplatonic tradition and particularly on the part which is of great import for Novalis's notion of "experiment". The affinity or "Verwandtschaft" (i.e. "sympathy"), of numbers, concepts, and their combinations, in thinkers such as Lull, Bruno, the Cabalists or Leibnitz lead, so Novalis thinks, to the possibility of another world. Here one is reminded of the art of "Combinatorik" as a tool of scientific discovery:

Die *allg[emeinen] Ausdrücke* der scholastischen Phil[osophie] haben sehr viel Aehnlichkeit mit *den Zahlen* - daher ihr mystischer Gebrauch - ihre Personification - ihr *musicalischer Genuß* - ihre unendlichfache Combination.
Alles aus *Nichts* erschaffne *Reale*, wie z.B. die Zahlen und die abstracten Ausdrücke - hat eine wunderbare Verwandtschaft mit Dingen einer andern Welt - mit unendlichen Reihen sonderbaren

> Combinationen und Verhältnissen - gleichsam mit einer mathem[atischen] und abstracten Welt an sich - mit einer *poëtischen mathem[atischen]* und abstracten Welt (*N*, 3, 440-441).

Both abstract "Ausdrücke" and "Zahlen" display an "affinity" to an "abstract world" or "Welt an sich", and "Sympathie" provides this bridge.

Among these many remarks formulated around his reading of Plotinos, the meaning of Novalis's "Combinatorik", and, in general of his encyclopaedic programme, becomes apparent. He most certainly was not carrying out any empiricist encyclopaedic programme such as that of D'Alembert. Instead, he is turning consciously to the Neoplatonic tradition and its notion of a "Combinatorik" of signs and concepts or ideas. The meaning of "thätiger Empirismus" is the notion that ideas are elevated to a form of experience in a highly "physical" construction of knowledge. The actual generation of ideas is linked up to the Neoplatonic tradition of experimenting with ideas and figures.

In this context Novalis speaks of "Plotins Physik". He is speaking of an empiricism that uses ideas in a Neoplatonic way; overtly "Plotins Physik" refers most probably to the way Plotinos constructed his hierarchy of Being, and the way he made the metaphysical "real" in constructing a hierarchy from the "One" downwards, which again is something Novalis later refers to as the base of his notion of science ("Unsre Physik ... ist eine reale Metaphysik oder Logik" (*N*, 3, 600)). Indeed, in the following remark on Plotinos, Novalis is speaking of the need for the sciences to use concepts which have "real metaphysical" value:

> Der Begriff Materie, Phlogiston, Oxigène, Gas, Kraft etc. gehören in eine *logische Physik* - die nichts von concreten Stoffen weis - sondern mit kühner Hand eigensinnig in das Weltchaos hineingreift - und eigne *Ordnungen* macht.
> *Plotins Physik* (*N*, 3, 179).

Novalis attacks here the conventional scientific wisdom that terms like "matter" can be used in a naïvely empirical way, by asserting that they actually belong to a higher category of being, they are not plainly empirical, but part of a "logic". These sorts of concepts are what Novalis also later refers to as "wircksame Begriffe" (*N*, 3, 600), they are concrete notions or models which the inquirer uses. The inquirer does not need to know of "concreten Stoffen" in a plain empirical sense since he is carrying out a higher form of empiricism that mediates between sheer experience and theory through the use of concrete notions, as is also and supremely the case, for example, with Goethe's "Urpflanze", with Schelling's forces, and with Ritter's incorporation of a model of the nerve into his electrochemical and physiological experiments. The "concepts" have metaphysical value since they are generalizations; they are abstractions from nature and part of an inner logic of the mind, and, like Neoplatonic magic numbers, these concepts are, in Novalis's view, perhaps in contact with another world. They are "real" because they are the product of a close association with Nature and are part of a "reale Metaphysik". Following this remark on "Plotins Physik", Novalis refers to the "Gefühl" that the scientist should have, and this again implies a concrete approach to knowledge, an intimacy with phenomena, a reliance on the inner sense, as has been seen in relation to Herder. Novalis envisages the "physical" nature of the process of discovery itself:

Zum Experimentiren gehört *Naturgenie*, d.ist, wunderartige Fähigkeit den Sinn der Natur zu treffen - und in ihrem Geiste zu handeln. Der ächte Beobachter ist *Künstler* - er *ahndet* das *Bedeutende* und weiß aus dem seltsamen, vorüberstreichenden Gemisch von Erscheinungen die Wichtigen herauszufühlen (*N*, 3, 179).

The demand for "genius" in the experimenter entails a parallel between him and Nature ("Naturgenie", "Sinn der Natur"). The use of innate ideas or concrete notions is to Novalis part of inquiry, complementing and assisting strict empirical inquiry. Novalis's meaning of "experiment" is not only that of a test, but also a drawing forth of knowledge and a placing back of it into experience. This is, as I have said, a practical form of knowledge, and literally has to be put into action. In this way Novalis's "magischer Idealismus" (*N*, 3, 385, 430) or his idea of treating the sciences "symbolically"[14] entails the use of models or concrete notions as aids in inquiry. Hence Novalis sees Plotinos as the first "generator" or "experimenter", using concrete notions operating on "Sympathie".[15] To use other terms: one can describe phenomenal calculus or the "Generationsmethode" as natural philosophical productivity or as pantheistic transreflexivity at work.

The whole Neoplatonic notion of continuity in the Chain of Being gives Novalis's idea of "phenomenal" calculus added meaning. The latter, too, is a continuous row, not of entities, but of thoughts, language, or experiments. Thus, although

Novalis's "phenomenal" calculus is related to its mathematical counterpart, as evinced in Leibnitz's notions of continuity and notation in his infinitesimal calculus, it represents a phenomenal form of the principle of continuity. Similarly, it grounds the unity of thought and matter at both methodological and ontological levels. As mentioned, Nisbet sees in Goethe's experimental method the principle of continuity reflected in the notion of a series of experiments with gradually visible distinctions, a form of methodology related in its structure to Leibnitz's gradual quantitative distinctions in his infinitesimal calculus. In the light of Novalis's transreflexive methodology, as evinced in his idea of the continual "Hin und Her" of thought, or in the progressive interchange of the "Experimentalmethode" and the "Beobachtungsmethode", Novalis appears to argue for the employment of the notion of continuity as fundamental basis for all thought. In laboratory work, one can speak of the progressive use of experiments and of the language of diagrams in discovery processes. For literature one can refer to the progressive use of symbolic, concrete language. Novalis's notion of phenomenal calculus, when seen in the light of the Neoplatonic notion of continuity, loses some its mathematical connotations, to become a more organic notion, both in the sense that the forms of knowing based around the principle of continuity are seen as phenomenal, and in the sense that knowledge so formed is driven on and organically "generated".

However, the principle of continuity does not offer the final theme in early Romantic ideas of knowledge formation and natural philosophical productivity. In Goethe, Novalis and Schelling there is, equally, what could be termed a dialectics of argumentation. Novalis's "Hin und Her", Schelling's polarities and Goethe's own use of polarities point to this. Novalis would have found a similar pattern of thought in Plotinos, for, as already mentioned, Plotinos's method of argumentation moved between the opposites of sensual and conceptual thought. Thus, what one sees in the works of Goethe, Novalis and Schelling links dialectics with the principle of continuity. A dialectical pattern of thought is employed within a greater pattern, the idea of continuity. Thus, for example, Goethe's "higher experience" is both the "dialectical" synthesis of all the experiments undertaken, as well as the "Formel", i.e. phenomenal "function" for all the series of experiments. Here the principle of continuity can be interpreted as the "phenomenal mathematics" of phenomena (i.e. plants operate according to the "function" of the leaf). Bound up within this process of thought is the further process of moving between opposites to attain progression in knowledge. Reference was made in the introduction to Schelling's analogous pattern of thought in his notion of the infinite series of Nature, which also operates according to a "function" and makes use of polar thought structures. In Novalis, too, within the series of experiments or thoughts, there is the further dialectic pattern of thought which moves between the conceptual and the sensual: both processes are united in his notion of knowledge formation.

### *1.9. Condorcet's general "Kalkul".*

It should here be mentioned, in the context of Plotinos's importance for Novalis's thought, that Novalis found a contemporary, mathematically and empirically based confirmation of his belief in concrete notation as a tool for discovery processes in Condorcet's work of 1796, *Entwurf eines historischen Gemähldes der Fortschritte des menschlichen Geistes* (*20*). It is worthwhile considering Condorcet, not in the light of the crucial philosophical issues arising from Novalis's reception of Plotinos, nor in the light of Novalis's broad notion of "experiment", but instead in view of Condorcet's role as a more "sober" protagonist of "Combinatorik". Condorcet's work was, for Novalis, more a lower level substantiation of the notion of "Combinatorik", than a key influence on his own concept of "Combinatorik", since Condorcet did not speak of "Combinatorik" explicitly in a Neoplatonic sense, but instead, in sober terms, treats the invention of mathematical calculus in empirical terms. However, since Novalis's remarks on Condorcet were written at the same time as his remarks on Plotinos, it is fair to assume that Condorcet further stimulated Novalis's interest in notation. Indeed, Novalis's remarks relating to Condorcet lead away from the strictly empirical and mathematical notion of "Combinatorik", to more general philosophical considerations. Novalis concentrates on two factors of mathematical calculus, its ability to predict (i.e. in the sense of discovering) and the fact that it was based upon the affinity (the "Verwandtschaft" or "Sympathie") of things:

> Kalcül = Kunst, *Bestimmungen zu verbinden* oder *Kunst zu bestimmen überhaupt* z.B. aus gegebenen Bestimmungen nicht gegebene Best[immungen] zu finden.
> Rechnungsl[ehre] = *Bestimmungsverwandtschaftslehre* (*N*, 3, 424).

Condorcet, although asserting how infinitesimal calculus operates on the relationships of things to another ("die Verhältnisse der Sachen" (*20*, 234)), never speaks of "Verwandtschaft" or "Sympathie". Condorcet does, however, hope for an elaboration of calculus and "eine allgemeinere, philosophischere Anwendung des Kalkuls auf alle menschliche Kenntnisse" (*20*, 297). Further, Condorcet saw scientific method itself as a calculus of experimentation. I quote the German version known to Novalis:

Die Naturlehre, die sich nach und nach von den durch Des Cartes eingeführten vagen Erklärungen reinigt, gleichwie sie sich der scholastischen Ungereimheiten entledigt hatte, ist nun nichts anders mehr, als die Kunst, die Natur durch Versuche zu befragen, um sodann durch den Kalkul allgemeinere Thatsachen daraus herleiten zu suchen (*20*, 240).

Condorcet underlines the precision of the empirical tradition and its truthfulness to experience and Nature: importantly for Novalis, he speaks of the possibilities of viewing experimentation as a process involving "Combinatorik" (although it must be emphasized that Condorcet's meaning of experimentation cannot be equated with Novalis's broader meaning). For Condorcet believed that the method of infinitesimal calculus could be used for all objects under investigation, provided that their "Elemente" were known, and the method would use their relationships with one another to determine their laws. Novalis recited, almost word for word, the following remark of Condorcet's in *Das allgemeine Brouillon*:

Nach Condorcet lehrt der Inf[initesimal] Calcül ... eine Methode, die da sie sich auf alle Combinationen veränderlicher Gr[ößen] und auf alle Hypothesen ihrer Veränderungen erstreckt, auf gleicher Weise für alle Dinge, deren Veränderungen eines bestimmten Maaßes fähig sind, ent[weder] die Verhältnisse ihrer Elemente, aus der Kenntniß der Verh[ältnisse], welche die Sachen gegeneinander haben, oder die Verhältn[isse] der Sachen, wenn nur die ihrer Elemente bekannt sind, bestimmen lehrt (*N*, 3, 425; *20*, 234-235).

To Novalis this meant that by studying the affinities ("Bestimmungsverwandtschaftslehre" (*N*, 3, 424)) of things for one another, and their combinations, discovery could take place. Novalis naturally had a broader notion of what actually constituted the relationship of things with one another, and this is apparent alone in his use of the term "Verwandtschaft", as opposed to the more neutral term used by Condorcet, "Verhältnis".

Condorcet, too, remains vague in the practical application of his notion of an empirical method, and Novalis's found his sources for a detailed method, or "experimentation" in action, elsewhere. Although Condorcet's line of thought readily appealed to Novalis, it is clear that he could not provide him with the sort of far reaching philosophical and metaphysical base or method he found in Plotinos, who far more profoundly affected Novalis's notion of "experiment" and "Combinatorik".

*1.10. Socrates: social and practical knowledge.*

If it is Plotinos to whom Novalis is particularly drawn for a broad method of inquiry, then it is Socrates who affords Novalis another aspect of ancient thought important for establishing a model for inquiry, this time not of a "Combinatorik" of innate ideas and phenomena, but of a socially oriented use of innate ideas. The remarks following those on "Plotins Physik" conjure up the potential of grand open inquiry and debate in the Socratic sense. Novalis seems to look at the project of modern science through the lens of the Renaissance, and ultimately, Greek philosophy:

Eine ganz eigne *Liebe* und *Kindlichkeit* gehört, nebst dem deutlichsten Verstande und dem ruhigsten Sinn, zum Studium der Natur. Wenn erst eine ganze Nation Leidenschaft für die Natur empfäht, und hier ein neues Band unter den Bürgern geknüpft wird, jeder Ort seine Naturforscher und Laboratorien hat, dann wird man erst Fortschritte auf dieser colossalischen Bahn machen, die mit ihr in Verhältniß stehn (*N*, 3, 179).

Here it is suggested that if the whole nation was aware of the scientific issues, and was impassioned by them, great progress would be made. The remark points to the role of social institutions in science. The observation once again employs Neoplatonic notions ("Liebe", "Band"), but places them into a contemporary context ("Bürger", "Laboratorien"). The insight links up to a remark Novalis makes close to his comments on Plotinos in *Das allgemeine Brouillon*, where he speaks of Socrates's ability to bring out the innate in man, i.e. his moral sense, if knowledge is supplied with a practical, experiential base of the kind Socrates always invoked. In this process a closer bond will then be formed between what man knows and what man does. Essentially, Socrates was trying to ensure that all knowledge was practical and "know-how", and this is also Novalis's understanding of the scientific community. Novalis's "Kindlichkeit" and the "moral organ" refer to experiential knowledge, be it innate or scientific experience:

Ansicht der ganzen Welt durch den *Moralsinn* - Deduktion des Universums aus der *Moral* - alle wahre Verbess[erungen] sind moralische Verbesserungen, alle wahre *Erfindungen* - moralische Erfindungen - Fortschritte. (Verdienste des Socrates.) (*N*, 3, 424).[16]

Socrates, thus, adds a further vital element to the tradition which Novalis constructs for his notion of "experiment", by virtue of his emphasis on "Moral" or practical knowledge, and, further, by his method of inquiry. The emphasis of the above remark is that all knowledge or true discoveries should be experiential, the outcome of an innate (moral), intimate bond with Nature. Thus Novalis's recourse to Socrates expresses part of the social aspect of his concept of "experiment", which will be discussed in the following chapters, as well as his fundamental attitude to knowledge. In heated open debate when Socrates went into the "agora" he was trying among the public to bring out into the open what people held innately within themselves. Through argument he sought to bring them to an understanding (i.e. a conception) of the purpose of their beliefs in their very justification of these beliefs (*287*). This means that it is not enough that people have innate knowledge; most important to Socrates, and to Novalis, is the fact that these ideas have to be "born", created, brought into action.[17] This birth would further enhance the desire for inquiry, for one would be in the best sense "physically" arguing for one's case.

*1.11. Summary of Novalis's notion of "experiment".*

Socrates's method brings us back to Novalis's meaning of "experiment": the "experiment" lies primarily in making knowledge an activity or an experience, the emphasis is not on proving something, but on the fundamental action of actually discovering something. "Experiment", then, to Novalis above all points to the process of inquiry and productivity in general. In all his remarks on his philosophy of experiential knowledge, whether Novalis is referring to a "Combinatorik", or the interplay of the "Plastisirungsmethode" and the "Beobachtungsmethode", or to the epitome of "Experimentalphilosophie" in Diogenes's steps, Novalis's notion of experiential knowledge implies the making of knowledge itself, and the varied ways of "knowing". Novalis's rhetoric of "experiment" in his phenomenal calculus is the key to his idea of natural philosophical productivity, and imbues "experiment" with strong elements of practical knowledge and aesthetics.

## 2. *The experimenter.*

### *2.1. Novalis's extension of the excitability debate to knowledge formation: a note on Fichte.*

Before illustrating Novalis's idea of the healthy experimenter, a brief survey of his stance on the excitability debate is required, since his concept of the inquirer's healthy mind is based on notions employed in this debate. Novalis was attracted to excitability theory as it came to mean the self-receptivity and self-activity of organisms, as proposed by the leaders of the German Brunonian movement, Andreas Röschlaub (1768-1835) and Schelling. Novalis wished to use and adapt some of the key Brunonian notions to approach ideas on knowledge formation itself. In a greater perspective, he further interprets the theory of "Erregbarkeit" as a "moral" pathology for Nature itself, viewing Brunonianism in terms of natural philosophical productivity. The Brunonian concept of sensibility, as will be seen, gives Novalis's natural philosophy another type of ethical edge, closely related to the ethical elements already discussed in early Romantic natural philosophy, but none the less adding a new perspective.

Novalis was well versed in excitability theory, although, as Neubauer has shown (*337*, 105-106), he had not read Brown's *Elementa Medicinae*. Instead, Novalis gained his knowledge of Brunonianism from Andreas Röschlaub, the renowned physician, who worked at the hospital in Bamberg and collaborated with its director Adalbert Marcus (1753-1816) in expounding a new system of excitability, the "Erregbarkeitstheorie". Novalis had read the first two volumes of Röschlaub's *Untersuchungen* (*101*) which came out in 1798: this work transformed what the Germans thought to be Brown's mechanical premises into a theory of excitability that accounted for the active role of organisms. Excitability was not viewed as a passive action and reaction by Röschlaub, but as a self-reproducing activity commanded by organisms which allowed them to respond to stimuli. According to Röschlaub, excitability accounted for reception to stimuli in a mechanist sense but also for the organism's own inherent activity ("Selbstwirksamkeit") in an idealist sense (*101*, §287; *337*, 106-7; *288*, 67). Novalis had also most probably read Schelling's *Erster Entwurf eines Systems der Naturphilosophie* (*108*) where Röschlaub's notions were taken up and developed. Indeed, Schelling developed and deepened his close links to Röschlaub, going to Bamberg in 1800 to collaborate successfully with him and to lecture there at the university (*288*, 65).

In the medical context at the end of the eighteenth century in Germany, excitability came to mean an active state of the body. The philosophy of Kant and Fichte played some role in establishing this view. According to Risse, it was Kant's notion of what a science should be that made physicians deem it necessary to give medicine an authoritative status through philosophical means (*288*, 69; *262*; *263*). Excitability could not be used as an *a priori* principle of true science in Kant's sense if it still had occult connotations. It was possibly Fichte's *Wissenschaftslehre* of 1794 and 1795, according to Tsouyopoulos, which, by its use of dialectics, gave excitability theory philosophical authority (*288*, 70-71). In the same way that Fichte established a relationship between subject and object at the level of consciousness, thereby giving philosophical status to the subject, so too could a relationship between organism (subject) and environment (object) be found in the notion of excitability. Thus, in accordance with Kant's demands, excitability was turned into a principle which eschewed the occult yet still gave significance to excitability, as Schelling argues:

Das dritte System setzt den Organismus als Subjekt und Objekt, Thätigkeit und Receptivität zugleich, und eben diese Wechselbestimmung der Receptivität und der Thätigkeit in Einen Begriff gefaßt, ist nichts anderes als was Brown Erregbarkeit genannt hat (*108*, 90).

Novalis makes use of Fichte's thought in a different manner to come to his own conclusions about the relationship of excitability theory to the activities of the mind. It is in this way that Novalis employs Fichte's idea of knowledge to arrive at suggestions for the pathology of knowledge formation. What Novalis saw in Fichte's thought was the ultimate phenomenon of the self-generation of thought. Thought was an organizing force, part of Nature's greater generative and creative powers:

Fichtes Phil[osophie] ist ein *Denkerzeugungsproceß* oder Organisationsproc[eß] - ein *Phaenomèn* selbst, oder ein *Factum* (*N*, 3, 477).

Novalis wished to apply Fichtian "active", self-reflexive thought to the forces of excitability, for he further notes down: "Begriff der *thätigen Reitzbarkeit und*

*Sensibilitaet*" (*N*, 3, 477). However, Novalis goes beyond Fichte's notion of thought to employ his own notion of transreflexivity: he would appear to be suggesting that through self-conscious thought, some control can be had over the forces of excitability, and also that through the transreflexivity of these thought processes, a further enhancement or improvement in one's pathology can be attained. Before coming to the thought processes that Novalis is speaking of here, we have first to introduce in more detail their counterparts at the level of strict pathology, namely irritability and sensibility.[18]

### 2.2. *"Sensibilität" and the constitution.*

Both Novalis and Schelling believed that "Sensibilität" was a deoxidation process of the nerve which led to irritability (oxidation of the muscles). Novalis remarks, "Das Oxigène nimmt an *Masse* im Verhältniß der Zunahme der Sensib[ilitaet] ab" (*N*, 3, 659). Schelling interprets these physiological processes in the light of the thesis of S.T.Sömmering (1755-1830) that high mental development was revealed in a paucity of nerves (*107*, 562; *337*, 98). Schelling regards an organism's "capacity", which is the amount of oxygen an organism can take in, that is, its irritability, as a sign of instability, and views "Sensibilität" as the highest, most stable organic force. Schelling further puts down an organism's freedom from mechanical causes to its sensibility, and views this as a movement of the organism away from the mechanical actions of irritability:

So hat also die Natur, indem sie die Bewegung der Willkür ganz zu überantworten schien, sie durch *Erhöhung der Sensibilität der Willkür* wieder *entzogen*; denn die Bewegungen der empfindlichsten Thiere sind auch am wenigsten *willkürlich*, und umgekehrt, die größte *Willkür* der Bewegungen ist in den trägen Geschöpfen. So nimmt mit steigender Sensibilität des Nervensystems das Willkürliche (Abgemessene) der Bewegungen durch die ganze Reihe der Organisationen, und sogar in Individuen derselben Gattung (nach Verschiedenheit des Geschlechts, Klimas, Temperaments u.s.w.) regelmäßig ab (*107*, 563).

As has been seen with Novalis's views of the relationship of Fichte's thought to excitability, Novalis wishes to extend the excitability debate into the realm of thought, and, ultimately, he wishes to apply excitability theory to cultural development itself. Novalis sees the dangers of what he views as his too sensible, "asthenic" age and wishes to counteract this trend. For Novalis viewed an organism's "capacity", that is, its irritability, as playing an important role in the stability of the constitution (*337*, 97-100). This view of the importance of irritability to the pathological constitution is reflected in his notion of a possible form of irritable thought. Novalis comments on the fragile state of knowledge in his age:

Wir sahen vorhin, daß Bildung und Vermehrung der Seele das wichtigste und erste Unternehmen ist. Äußere Reitze haben wir schon in unsrer Hand - und mit ihnen die Reitzbarkeit - es kommt nur vorzüglich auf Vermehrung und Bildung der Sensibilitaet und zwar auf die Weise an, daß die Reitzbarkeit und der äußre Reitz nicht dabey leiden, nicht dabey vernachlässigt werden - denn sonst webt man ein sehr zerreißbares Gewebe, und ein Gewebe der Penelope ... (*N*, 3, 318).

Although Novalis here emphasizes the fact that man must concentrate on the "Bildung der Seele" and its sensibility, he proposes a method that takes account of irritability ("die Reitzbarkeit und der äußere Reitz"). Furthermore, "Sensibilitaet" here refers to sensibility in its cultural context. With "Sensibilität", Novalis is referring to all of man's forms of knowing, and not to the pathological force of sensibility alone. Novalis also refers to irritability as an external condition, and in this sense he is speaking literally of the effect of the environment or medicaments or other such possible "external" factors on man's constitution. Yet the general gist of the comment, as other remarks of Novalis show, points to the possibility of "*internal*" irritable "sthenic" factors, that is, of the "physical", "phenomenal" nature of knowing. "Irritable" forms of knowledge are those such as "Gefühl", "Reflexion" and "Plastisirung". These particular "sthenic" activities of the mind are used with the "asthenic" activities of the mind, reason, speculation and abstraction, to keep the constitution stable and healthy. A constitution which was too asthenic should use sthenic means to obtain a healthy balance, and a sthenic constitution should employ asthenic means. Novalis remarked about his own asthenic, over-excitable state:

Durch Abstraction wird die Reitzbarkeit vermehrt. Zuviel Abstraction erzeugt Asthenie - zuviel Reflexion Sthenie. Ich muß viel reflectiren und nicht viel abstrahiren. Ich bin schon reitzbar genug (*N*, 3, 289).

However, these irritable forms of thought are not only an important factor (in conjunction with the sensible ones) in the healthy balance of the constitution, but they are also crucial for the attainment of truth. They indeed play a major role in inquiry itself, for they are those concrete forms of thought which mediate between theory and phenomena, and which play so key a role in natural philosophical productivity.

It should be noted that Novalis's notion of sensibility has to be viewed in the light of his knowledge programme, where the final goal is the union of the conceptual and the concrete (in "Figurworte" and "Wortfiguren"). Here, sensibility is a grand process, it is the process of knowledge attainment, and the analogous "creative", organized processes in Nature. Novalis places particular emphasis on "irritable" activities, since the creator of "Figurworte", in the process of "plastisiren" in the "Experimentalmethode" is the "Genie" (*N*, 3, 123-4). Nature, too, in her "Chiffernschrift" is essentially "plasticizing". Thus, the danger of the fragile web ("ein sehr zerreißbares Gewebe"), i.e. the process of sensibility, which does, in the process of attaining knowledge, necessarily contain abstracter asthenic activities, can be avoided and made "robust" through analogous concrete forms of knowledge ("Plastisiren"). In the terms of Novalis's knowledge programme, the asthenic forms of knowledge, have, in a progressive unification with concrete sthenic activities ("Hin und Her"), to move towards a higher, concrete way of "knowing" and concrete theorizing, where, like Nature, they would be permanently "plasticizing", and knowledge would be both experience and activity. Here, in the genius's "Experimentalmethode", "experiment" is the epitome of experiential knowledge.[19]

### *2.3. "Freyes Nachdenken": generating knowledge within the bounds of the constitution.*

In the sense of the "constitution" of knowledge itself, those entities at the higher end of the Chain of Being, the "Ideen", are kept in a healthy state by the irritable forms of knowledge, since "Gefühl" and "Begeisterung" help maintain the generative drive in knowledge itself, the "Wissenstrieb":

Durch unaufhörliches freyes Nachdenken muß man sich begeistern. Hat man gar keine Zeit zum Überschauen, zum freyen Meditiren, zum ruhigen Durchlaufen und Betrachten in verschiednen Stimmungen, so schläft selbst die fruchtbarste Fantasie ein, und die innre Mannichfaltigkeit hört auf. Für die Dichter ist nichts nüzlicher als eine flüchtige Betrachtung der vielen Weltgegenstände und ihrer Eigenschaften, so wie der mancherley Wissenschaften.
Ich lese jezt zu wenig und meditire zu wenig.
Wieder etwas Chymie - Physik - Geographie - Geschichte[.] - Alte Kroniken etc. Don Qu[ichote.] Shaksp[eare.] Göthe. Tiek. Boccaz (*N*, 3, 655).

This observation can be understood as a series of practical hints as to how to reactivate the "Wissenstrieb". The suggestions are a useful aid for any inquirer, including the scientist, perhaps, stagnating in excessive laboratory work. "Freyes Nachdenken" opens up new possibilities. In accordance with Novalis's notion of a "Combinatorik", the free play of thought allows man to operate using the grand "Sympathie" of things and to move between various modes of knowing. Elsewhere Novalis speaks in a similar manner of the need for viewing knowledge in terms of the balance of one's constitution:

Höher kanns der Mensch nicht bringen, als daß er einsieht, welches Wissen sich just für seine Stufe paßt - für die Dauer und Constitution seines Lebens - und den Wissenstrieb nicht krankhaft begünstigt - ihn in Harmonie mit seinen übrigen Kräften und Anlagen läßt (*N*, 3, 600-601).

The process of knowledge demands to be conducted with self-awareness, so that it advantages and does not harm the investigator. "Freyes Nachdenken" can both afford a welcome break from inquiry as well as provide the material, perhaps, for innovations and breakthroughs.

*2.4. Werner's encyclopaedic methodology: the constitutive rules of general and personal inquiry.*

As already remarked, a full study of the relationship between Novalis and Werner cannot be undertaken here. I wish instead briefly to recapitulate the points made in the introduction, and, further, to consider an important part of Werner's thought, namely his teaching methods, which are reflected in his idea of an encyclopaedic methodology. It will be suggested that a highly significant aspect of Werner's influence on Novalis (and, one can conclude, on his other students) lay not only within the realm of general methodology, but also specifically within the area of personal knowledge.

Werner's theory itself ought to be understood as practical theory, as Novalis himself points out:

Werner hat die *Theorie* eines *speciellen* Beobachtungsprocesses geliefert - Auf diesem Grunde kann man weiter bauen -
*Allg[emeine]* Theorie des Beobachtens und Experimentirens - und Einzelne, specielle Processe, als Beyspiele.
*Practische* Theorie d[es] B[eobachtens] und Exp[erimentirens] (*N*, 3, 437).

One can say that Werner's mineralogical classification system, his "theory", is actually more concerned with the practice of inquiry than "theory" itself. In the above remark, Novalis wishes to extend Werner's more tacit remarks on methodology in his classification system to an explicit theory of practice. As will be discussed below, Werner approaches the issues of practice explicitly in his teaching method. Part of Werner's "Beobachtungsprocess" is concerned with directly theorizing with phenomena, and this is how Werner approaches the task of classifying rocks. This aspect of Werner's thought involves issues of tacit knowledge, since it implies the necessity of having a "feel" for phenomena, and, also, for the reason that observation of phenomena is undertaken within a theoretical framework of open-ended concepts or paradigmatic types. Thus, his theory both offers a method for investigating phenomena and provides mineralogical or geognostical schemes with which the individual inquirer can carry out his research. It is in this sense that one can argue that Werner was concerned with setting constitutive rules and providing some form of a presuppositional framework for inquiry.

As has been seen, Novalis extrapolates from Werner's practical theory to suggest that in a "phenomenal" calculus Werner's types could be combined to further inquiry. Following this train of thought, Novalis also refers to Werner's classification system as a sign language: "die Zeichenlehre der äußern Kennzeichen" (*N*, 3, 141). Clearly, in Werner's working method, and in his classification system itself, Novalis saw a form of his own idea of concrete notation that he later developed. This is, arguably, a major influence on Novalis's own idea of consensuality in the sciences, as will be further illustrated in Novalis's reception of Ritter's work.

To complete the picture of the importance of Werner's thought for Novalis in terms of setting constitutive rules for inquiry, one must also consider the methodological part of Werner's notion of encyclopaedism. The "Methodologie" of Werner's encyclopaedic programme acts in parallel with the "theoretical" part: importantly, both parts form the whole picture of Werner's idea of encyclopaedic inquiry. His encyclopaedic theory aims to provide interdisciplinarity; to complement this, the encyclopaedic methodology is concerned with the equally important part of inquiry for Werner, the all-round education of the individual. In this part of Werner's encyclopaedism particular emphasis is laid upon the manner in which the individual comes to terms with theory ("die Regeln des subjectiv zweckmäßigen Studiums und Exercitiums"). According to Novalis, Werner's methodology further suggests that theory has to accommodate the individual's needs ("Karacter des Kopfs"), and that the individual has to practice and inquire beyond his own discipline ("Neben und Hülfsstudien"). Part of Werner's methodology also involves the organization of studies themselves; here it is implied that the individual's ordered use of his time is, too, a necessary part of any approach to inquiry ("Ordnung und Folge der Beschäftigungen") (*N*, 3, 394-395). This is a broad programme of education that is aimed at helping the individual get the most out of theory, and, more importantly, himself, in his studies. In this way, "theory" as such is relegated, and the manner in which the individual comes to terms with knowledge is placed at the forefront. This activity is, it would seem, indispensable to theory itself. Not only does Werner stress the practical skills needed for inquiry, but also, significantly, the manner in which the inquirer comes at all to attain knowledge. Consequently, it can be perhaps be suggested that the methodological part of Werner's encyclopaedism treats the essential basis of all inquiry, namely the way the individual comes to terms with knowledge and the world. This is an essential aspect of Werner's constitutive rules for inquiry, and, in its programmatic nature as part of a notion of encyclopaedism, must have influenced Novalis's own broad views on practical knowledge and the healthy experimenter.

*2.5. "Freyes Nachdenken" in practice: mechanics, excitability and Ritter.*

To conclude this section on Novalis's idea of the experimenter, it is appropriate to give an illustration of just what "freyes Nachdenken" looked like in practice. An example of this can be found in *Das allgemeine Brouillon* - itself a mass of "freyes Nachdenken" - in a remark of Novalis's where he approaches some fundamental physical statements in terms of excitability theory. He carries this act of thought out with his "phenomenal" calculus, and thereby relativizes notions of excitability and physics in a process of concrete theorizing. In this remark, Novalis speaks in one breath of uniting excitability theory and Newtonian mechanics: mechanics and excitability are, in Novalis's view, only relative schemes employed by scientists. Indeed, Novalis would prefer to approach these forces in a way analogous to Ritter's stance on galvanism. Ritter, as will be seen, relativized the current schemes in the galvanic debate (briefly stated: Volta's notion of contact electricity and Humboldt's idea of a specific life force), to arrive at a more fundamental notion of galvanism, the purposive constant galvanic life force. This force expresses a deeper level of theory which effects both notions of contact electricity and an animal life force. In this style Novalis wished to approach excitability and mechanics:

> *Umstoßung* der Gr[und]gesetze d[er] *Mechanik* - und Erregungstheorie.
> Keine Bewegung ohne Sollicitation etc.
> Meine Sätze:
> Alle Bewegung und Erregung entsteht nur d[urch] Bewegung und Erregung.
> Reitz und Beweglichkeit sind nur Verhältnisse von Bewegungen.
> Alles was erscheint z.B. Bew[egung] und Erreg[ung], war schon vorher da.
> Aller sog[enannter] Reitz stört die Bewegung und Erregung vielmehr - polarisirt sie - und nun wird sie, als gestörte Bewegung und Erregung sichtbar.
>
> So unordentlich und confus diese Sätze auch sind so reichen sie doch zu - die Substantialitaet - und Ursprünglichkeit d[er] Bew[egung] und Erreg[ung] und die Verkehrtheit der bisherigen Sätze, die nur *relative* Gültigkeit behalten, darzuthun. (vid. Ritters galv[anische] Versuche.) (*N*, 3, 387-388).

Although Novalis calls his propositions "confus", they are more or less quite coherent, and constitute a stance in many ways typical of early Romantic science. Characteristically, they aim to discover final causes in new ways. Novalis's comments appear to be aimed at unreflective scientific views, that of common Newtonianism and that of crude Brunonianism. Firstly, Novalis posits the overturning of conventional mechanics: "*Umstoßung* der Gr[und]gesetze d[er] Mechanik ...". This "Umstoßung" effectively entails a denial of Newtonianism and its physics, as it was commonly received in Novalis's time (*276*, 27-38), and of its primary role as a paradigm and basis of modern science. By the same token, he denies "Erregungstheorie", representative of the human sphere, but - like mechanics - so Novalis appears to think, based on laws of cause and effect. Both mechanics and the German Brunonian notion of excitability are based, in his view, on action and reaction: "Keine Bewegung ohne Sollicitation". In contrast to the model of thinking established from Galileo to Newton, which interprets the actions of matter in terms of mechanical causes and effects (or in terms of mechanically conceived forces like "gravity"), Novalis proposes seemingly circular "Sätze", in which "Alle Bewegung und Erregung entsteht nur d[urch] Bewegung und Erregung". He thinks not in terms of the laws of motion, which describe states, actions, and reactions of bodies, but - in a non-Newtonian way - seeks the *cause* of motion, which he finds in motion itself, i.e. in the autogenesis of movement. It is a perspective developed out of the philosophy of Kant and Fichte, and applied with startling results to science. On Newton's theory, the cause of gravity notoriously originated outside of matter, e.g. "in the breast of God"[20]; thus, on the traditional reading, Newtonian physics rests on a framework of theology which lies beyond physics, and outside of the sphere of scientific inquiry; Novalis's quasi-tautological laws, by contrast, in fitting with his pantheism, seek to ground a physics in terms of a transcendent force throughout Nature. Whereas Newton's laws deal in matter, motion, rest, and so on (which can be interpreted together in terms of "force"), Novalis seeks a single first principle, a "motion" itself, from which further consequences arise; the phenomena of "Reitz" and "Beweglichkeit" are simply manifestations of this first principle, and in this sense they are "relations" ("Verhältnisse"), which previously existed in the original "motion" ("Alles was erscheint ... war schon vorher da"). This leads to a reinterpretation of action or "Reitz" as a disturbance of "Bewegung" and "Erregung". On this theory, "polarity" does not appear to be a primary phenomena, but, rather, the product of a disturbance in the original process of "movement". In the same manner, to Novalis, the polar forces of the German Brunonians, "Irritibilität" and "Sensibilität", and their notions of polar physiological states, "Reizbarkeit" and "Erregbarkeit", are secondary phenomena. It follows that Ritter's notion of a constant galvanic force was, for Novalis, a major step towards an understanding of a fundamental process, and indeed towards a "proof" of the fallacy ("Verkehrtheit") of traditional views of physics and organization. Schelling, too, was well aware of this point, for he expressly welcomed Ritter's work on galvanism, and viewed it as an important extension to the excitability debate (see chapter four). As can be seen from this example, Novalis's form of "freyes Nachdenken" is highly productive, and illustrates clearly how the experimenter or inquirer can have recourse to creative sources within himself, which also, importantly, help maintain the balance of his constitution.

Chapter Three

# Unifying theory

The possibility of natural philosophical productivity as a programme for classifying the sciences.

*1. Introduction. "Symbolische Physik", "Muster" and "Calcül". Intimations of a programme for natural philosophical productivity to unify theory.*

The subject of this chapter, Novalis's "symbolische Physik", will lead us to consider the possibility of natural philosophical productivity as a programme for unifying theory, and immediately raises the question of the social orientation of Novalis's work. To what extent did Novalis see his views on the sciences as practicable for a community? To what extent does Novalis's thought deal with knowledge as a social construct? The next chapter also raises these questions, but approaches the issues in terms of the consensual implications of the unification of practice.[1] However, this chapter is tentative in its views about the practicability of Novalis's notion of a "symbolische Physik" for a community of inquirers, but this chapter is quite clear in its view that Novalis's notion of knowledge is not a social construct.

The social elements of Novalis's thought have to be seen as a form of practical knowledge. The intellectual determinents are so embedded in the sociological aspects that one cannot speak of social construction alone.[2] Novalis takes up a stance that allows for a breadth of intellectualism - in his notions of practical knowledge and in his views on the links of the purposiveness of nature and man's consciousness - and also accounts for social elements of knowledge. Through his emphasis on productivity this is a stance that mediates between social and epistemological elements of knowledge. Taking the case of phosphorus, he argues, like Goethe, for the epistemological value of "phenomenal bases" for research programmes, as well as the clear sociological aspects of such bases - since they are supposed to be used by a community.[3] It will be shown how phosphorus was the phenomenal base for many a question posed by the inquirer in the pneumatic debate. Thus, in Novalis's emphasis on knowledge formation or productivity, social and intellectual elements of knowledge fall together, yet with a clear emphasis, in a non-relativist manner, on epistemology and cognitive gain.
Taking a closer look at possible points where knowledge could be deemed a social construct, we can see that Novalis's notions of knowledge cannot be profitably interpreted in terms of the effects of institutions and power alone. If anything, if these sort of sociological elements are there, Novalis makes the suggestion that such institutional differences should be overcome in open debate in the lecture

theatre. Secondly, he argues that such differences are to be overcome through a consensuality based upon the topic of inquiry, and not upon aspects of an institution. This may sound like a more utopian form of sociology, but, none the less, the goals are not set as high as, for example, in von Molnár's interpretation of a communicative social construct. In the social aspects of Novalis's programme of knowledge for unifying theory we have a lower level form of consensuality, suggested in a symbol such as phosphorus; further, this is coupled with the quite legitimate and sensible suggestion that scientists should defend their views in debate. Moreover, related to the idea of debate, as Novalis comments, is the use of the dramatic value of a good experiment in a lecture hall. This is again a socially oriented form of knowledge, but the epistemological issues thoroughly outweigh any notion of the social construction of knowledge. The use of a good experiment - such as a dramatically convincing one - is, of course, more then drama alone. Firstly, such an experiment is bound up with the theoretical scientific issues it is dealing with, and has the potential to communicate these issues. Secondly, such an experiment has to be viewed in terms of its epistemological element as experiential knowledge for its spectators: cognitive gain is available through the experiment for each individual.

Novalis's idea of socially oriented practical knowledge in his programme designed to unify theory is expressed in terms such as "symbolische Physik" or "die Formularwissenschaft oder Kunst der Natur" (*N*, 3, 175). These more socially oriented terms - which suggest a usable system of symbols - are, to a certain extent, also used by Novalis in the sense of his perhaps less socially oriented notion, "Plotins Physik". As with "Plotins Physik", it is the task of a symbolic physics to find out the key elements to be used in a "phenomenal" calculus of inquiry, and Novalis calls such a key element for symbolic physics "das Formular" or "Muster" (*N*, 3, 175) - Novalis sees just such a "Muster" or key element of inquiry in phosphorus.[4]

Importantly, the construction of a symbolic system for the sciences and its development in the "phenomenal" calculus of inquiry, itself indeed a large claim, fits into Novalis's expectations of this time. He was thinking of such grand systems, such as the related encyclopaedic programme in *Das allgemeine Brouillon*. In his later thoughts there is, arguably, a move away from such large projects towards the individual attainments of an inquirer such as Ritter. None the less, even if the massive undertaking of such a symbolic science was not realized by Novalis - in the present state of Novalis scholarship more symbols for such a programme still have to be found -, there is evidence that phosphorus did act as a consensual metaphor for the pneumatic debate. Thus, there are grounds for saying that Novalis saw in phosphorus the sort of "Muster" he desired for his symbolic physics. However, even given these undoubtable social orientations, the manner in which Novalis refers to phosphorus as a "Muster des Experimentirens" would appear to point more to its general use as a paradigm for inquiry and to the epistemological aspects of inquiry. Novalis, it seems, is more concerned with the application of the symbols of inquiry than nominating members of such a system of symbols required for a large scale programme. Thus, his ideas on a programme for natural philosophical productivity remain more at the level of methodology - and this will become particularly apparent in the next chapter. Characteristically, Novalis's remark on the "Muster" of phosphorus is almost inundated with reference to "experiment":

*Vervielfältigung* - *Wiederholung* - *Zertheilung* - (Addition - Multiplication - Exponenziation etc.) von Experimenten. Zusammensetzung von *Experimenten.*
(Experimentencalcul.)
*Experimentiren* ist gewissermaaßen nichts, als *calculiren.*
(Aller Calcül ist Analytisch - inventorisch)
Muster des Experimentirens.(Phosphor - Kampfer) (*N*, 3, 435).

In this observation Novalis, in line with his experiential notion of knowledge, is stating above all the precedent of experiment over theory itself. Consistent with his concept of practical knowledge Novalis is implying that more fundamental to knowledge and the sciences are not the formulation of theoretical statements or the testing of hypotheses, but how one obtains the theory in the first place, and also as the notion of "experimental calculus" suggests, a constant recall to experience, a calculus forever turning to "experiment". He is referring to calculus of literal series of experiments in the laboratory, and to the calculus of images in the mind. Novalis's notion of "experimental calculus" is "Analytisch" in the sense of having predictive ability ("inventorisch"), analogous to the mathematical "analytical calculus", and is a method of speeding up the process of knowledge gaining, which is also of use, in Novalis's eyes, for the open chemical debate.

In his notions of "Experimentencalcul" and "Muster" Novalis is speaking of a calculus where a constant factor is selected, as part of the notation. Novalis chooses phosphorus and camphor as particularly significant chemical phenomena ("Muster") to be used in this manner. In this context, he wished to sees them as a phenomenal base for a calculus around which theory in the pneumatic debate could orientate itself. "Experimentencalcul" does not imply random experiments or the attempt to calculate "infinite" rows of experiments. Novalis wishes to supply inquiry with a phenomenal base that always directs the scientist's attention to the key phenomena. The consensuality of such symbols carry both sociological and epistemological implications, in their use by inquirers and in their cognitive elements for the individual or group of scientists, respectively.

As will be seen, the reason why phosphorus and camphor were paradigms ("Muster") of experimentation lay also in their usefulness for Novalis's own notions of chemistry and matter theory. Phosphorus was, however, outside Novalis's thoughts, a commonly used substance in experimentation, and can thus be seen as a common paradigm for chemical inquiry. The very usefulness of the substances phosphorus and camphor for inquiry suggests to Novalis that the substances are in a way analogous to theory itself. To Novalis they are so exemplary of physical and chemical action that they can provide a concrete link between phenomena and theory. In this way, the substances have proven themselves as worthy enough to be elevated to principles for natural philosophical productivity, and, as Novalis implies, they can be employed as the basis of a "phenomenal" calculus for chemical inquiry. It should be added that it was common chemical practice to make use of analogies between substances, and Novalis's idea attempts to give this natural philosophical justification. Of course, the scope of natural philosophical productivity's goals go beyond unreflective empirical inquiry. Yet, in another sense, and as for example in this case of the common use of analogy in chemistry, Novalis's ideas here can be seen as an attempt to express the tacit practices of the empirical inquirer. One can speak of tacit practice, or at a more reflective level, one sees again the meaning of Novalis's rhetoric of experiment. Here, one can note how experiment is based upon the variation around the constant notation of phosphorus, i.e. re-experiencing a key phenomenon in a productive way. The rhetoric lies in these aesthetic and practical elements of natural philosophical productivity.

Further, necessarily implicit in Novalis's reference to "Experimentencalcul" is also the idea that chemistry itself is a paradigm for knowledge, since the two substances are used in the context of chemical experimentation. But it is a particular form of "Chemie" which Novalis is referring to, that of a general "Physik". Like Schelling, he argues, for instance, in the *Freiberger naturwissenschaftliche Studien*, that "Chemie" is more important than traditional mechanics for an understanding of matter, since mechanics only deals with "Gewicht" and "Ortsveränderung":

Ortsveränderung ist der Bewegung nicht wesentlich ... Die Mechanik hat nicht mit Körpern sondern nur mit Gewichten zu thun (*N*, 3, 77).

More essential to matter theory are the internal processes in matter, which is what chemistry concerns itself with. Importantly, the sort of chemistry that Novalis is working on is the chemistry which overlaps with physics. This goes beyond Lavoisier's (1743-1794) chemistry, for although Lavoisier also incorporated physics into his chemistry through the notion of "caloric", he refused to broach the broader physics of a deeper level of matter theory. The sort of "physics" that Novalis espouses is the "physics" which goes beyond mechanics to account for dynamism and forces such as affinity. Novalis - in common with many contemporaries - perhaps viewed Lavoisier's chemistry as akin to the French revolution, which he saw negatively as a triumph of reason, as opposed to of spirit.[5] Similarly, for Novalis, Lavoisier's chemistry evaded important issues. One could say it avoided the theoretical problems of the "spirit" of inquiry, being more concerned with rapidly setting up a "state" for chemistry. This view of Novalis's will be further substantiated in the course of this chapter. Further, a variety of views held by Novalis will be discussed in the context of his broad understanding of chemistry. Novalis does not hold back from introducing subjects such as excitability or digestion to enhance his notion of matter theory. An occult notion such as "Sympathie" is also, understandably, given its ontological importance for Novalis, drawn into his thoughts in this area. In *Das allgemeine Brouillon* Novalis speaks, for example, of how the world and man are driven by "Lust und Unlust" (*N*, 3, 423). There are also a variety of remarks made by Novalis which are not so speculative. As mentioned, these types of remarks orientate themselves around the justifiable concerns of the Romantics, and other strictly empirical inquirers, over the need for a discussion of forces going beyond Lavoisier's notion of chemistry.

*2. Phosphorus and the pneumatic debate in the 1790's.*

*2.1. Phosphorus's role for consensuality and for phenomenal calculus: "Muster des Experimentirens" and "Experimentencalcul".*

Phosphorus was the substance most replete with implications for Novalis's thought; camphor is also of significance but not to so great an extent and will be dealt with more briefly. Looking into the history of phosphorus, it becomes evident why Novalis should have selected it as a tool for inquiry and as a paradigm for experimentation. Ever since its discovery by the alchemist Hennig Brand around 1674 (*252*, 62) phosphorus combusted its way through the latter part of the seventeenth century and throughout the eighteenth century, igniting chemical theory.

Most obviously, phosphorus was used in many fundamental experiments on combustion and the constitution of air. Robert Boyle (1626-1691), for example, having been given some notion of how to prepare phosphorus in 1677 by Krafft (who had bought the secret off Brand) (*252*, 62), went on to produce and use phosphorus in his work on combustion in 1681/82, recorded in his *New Experiments, and Observations, made upon the Icy Noctiluca* (*14*). Here he remarks, after reporting on closing phosphorus in a glass tube, that "the air had some vital substance preyed upon or else tamed by the fumes of the phosphorus".[6] Boyle also undertook substantial work on the properties of phosphorus itself.[7] Stephen Hales (1677-1761) employs phosphorus in his experiments on combustion in his celebrated work of 1727 *Vegetable Staticks* (*48*).[8] Carl Wilhelm Scheele (1742-1786), the discoverer of oxygen, experimented with phosphorus in his work of 1777 on combustion, *Chemische Abhandlung von der Luft und dem Feuer* (*103*).[9] Further, in the pneumatics debate of the 1790's, phosphorus was again used, as in the above cases, to serve as a major tool in the inquiry into combustion.

The mysterious properties of phosphorus, such as its glowing in the dark and its spontaneous combustion, presumably also stimulated interest amongst the alchemists, since they concerned themselves above all with the effect of heat on substances in general (*252*, 65). Phosphorus is, too, of significance in the light of the alchemical sulphur-mercury theory. This was a tradition based upon the ideas of the Arabian alchemist, Jabir ibn Hayyan (720-813), who maintained that all metals were composed of sulphur and mercury, and his theory was taken up by most alchemists in their quest to bring about the transmutation of metals. It survived until the arrival of the phlogiston theory late in the seventeenth century (*201*, 75). The theory also lived on, although modified, in Paracelsus' (1493-1541) spagyric alchemy. Paracelsus's three primary principles, the tria prima, also known as the "hypostatical principles", were salt, sulphur and mercury (*201*, 174). These particular substances were however not taken literally by alchemists, they were rather understood in a symbolic or hypothetical sense. For example, sulphur, as an alchemical principle, signified combustible substances in general (*201*, 75, 174-175).[10] It is as a symbol of combustion that phosphorus, like sulphur, might have taken up a position at the heart of alchemical thought.[11] Indeed, in the alchemical work *Quadratum alchymisticum* (*87*), which is on Novalis's book list early on in the *Freiberger naturwissenschaftliche Studien* (*N*, 3, 34-35), there is a very probable reference to sulphur[12] in the above sense, as a hypothetical substance, in a symbolic diagram and scheme for the proposed path to attain the "Lapis Philosophorum" (*87*, 78) (see below, fig.3).

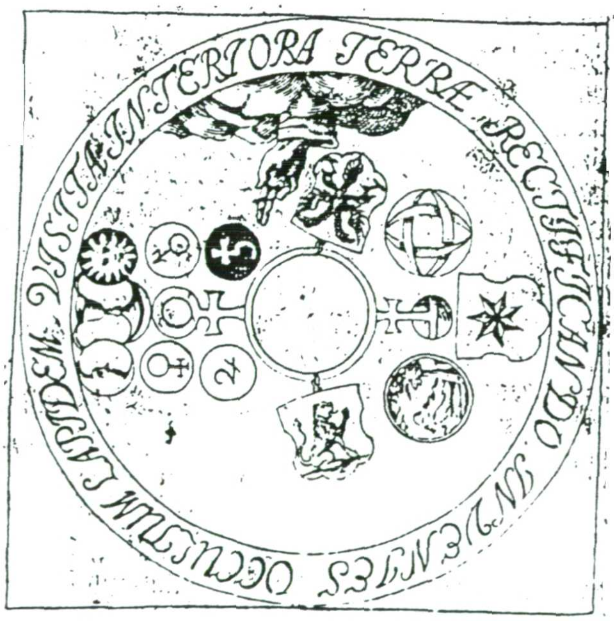



*Fig.3. Alchemical symbolism in Quadratum alchymisticum, (1705).*

The symbol of the eagle represents "die Weise und Röthe🜍is" (*87*, 73), i.e. the hypothetical "sulphur", which was indeed common in alchemical usage. The alchemical symbolism in the diagram also throws light on the concrete nature of Novalis's idea of a notation of the imagination and on the symbolic, paradigmatic significance Novalis attached to phosphorus. Alchemical symbolism does indeed bear considerable similarities to the type of concrete theorizing which Novalis argues for.[13]

Furthermore the term "phosphorus" was always symbolic of all carriers of light, since it literally means "light-bearing", its roots lying in "φws" (phos) = "light", and "φόpos" (phorus) = "bearing". It also had direct associations in an etymological and occult sense with Lucifer (lux = "light", and ferre = "to carry"), and hence also with Venus, the morning star. So phosphorus was a loaded concept and substance, always redolent of something more than its strict chemical meaning.

Thus, even before the pneumatic debate in the 1790's, phosphorus was, to use Novalis's expression, exemplary ("Muster") amongst chemical substances. The historical meaning and the use of phosphorus both supported Novalis's view that the sciences had to be understood in the broadest sense of "knowledge". Science had to take account of productivity in discovery processes (the sense behind such an alchemical recipe as the one illustrated above), and, further, science had in a variety of ways to approach matter theory with an eye to forces and purposiveness. Novalis's view was, however, a forward-looking approach, for he did not wish phosphorus to be viewed as exemplary in the sense of the particular symbolic associations it had for alchemists. Instead, he strove in his remarks to identify phosphorus as a symbol of the emerging science of modern chemistry. This did not exclude older views. He wished the modern scientist to maintain an imaginative state of mind such as an alchemist's, while relinquishing alchemical theory, and instead to insert a symbol such as phosphorus into the newest chemical theory. Further implied in the notion of a "Muster" is the fact that phosphorus was the symbol of all pneumatic theory in the 1790's. Like an alchemical principle, it was an approximation of the theory; or, in an epistemological sense, phosphorus was the concretization of theory. This is no speculative leap of Novalis's. Rather, it can be understood as an attempt to keep the complexity of the as yet unresolved pneumatics debate under a single denominator. In terms of Novalis's

"Experimentalphilosophie", the use of phosphorus as a symbol afforded the scientist the possibility of linking the various theories to experience, and, indeed, back to the experiments in the laboratories themselves, where the phosphorus was vividly burning, physically and in the imagination. Just how much phosphorus was used in the phenomenal calculus of the pneumatic debate remains now to be shown.

Phosphorus's role in the pneumatics debate ought not to be underplayed. For example in Gren's *Neues Journal der Physik* (*73*), in the years 1795-1797, phosphorus is the subject matter of no less than thirteen articles, twelve of those alone in the volumes published in 1795 and 1796. In Scherer's *Allgemeines Journal der Chemie* (*5*) phosphorus is the subject of two letters and six articles in 1798, of one article in 1799, and of five in 1800. There is, in this experimental context, considerable variation in the theories on pneumatics and combustion. Moreover, given the sheer amount of work carried out in this area, it is not difficult to apprehend just how important pneumatics were for the chemistry of the time. Pneumatics were important alone for Lavoisier's elemental chemistry, but pneumatics and its broader implications were also highly significant for 'Physik' when attempts were made to go further than Lavoisier's chemistry to define deeper levels of matter theory, as in the area of affinity, and, as with notions which were precursors to some idea of energy. Eighteenth century "Physik" clearly had broad parameters, and included chemistry, as can be seen, for example, from Gehler's *Physikalisches Wörterbuch* (*37*), to which Peter Kapitza has drawn attention (*322*, 22):

> Physik, Naturlehre, Naturkunde, Naturwissenschaft. Diesen Namen führt die gesamte Lehre von der Natur oder Körperwelt, oder von den Eigenschaften, Kräften und Wirkungen der Körper. Im weitläufigsten Sinne des Wortes gehört zur Naturwissenschaft alles, was jemals über die Körper erfahren oder gedacht worden ist (*37*, 3, 488).[14]

The overlap between physics and chemistry goes back at least as far as Newton. For instance, it is now widely agreed that the study of affinity, so important for "Chemie", finds an important precedent, in fact nothing less than a programme, in the *31st Query* of Newton's *Opticks* (*74*; *129*, 51-57; *154*, 5). Here, Newton suggests that the study of affinity would complement his physics and would provide a full picture of Nature, based on the traditional notion of the analogy between all things, the *analogia entis*:

We must learn from the Phaenomena of Nature what Bodies attract one another, and what are the Laws and Properties of the Attraction (*74*, 376);

And thus Nature will be very conformable to her self and very simple, performing all the great Motions of the heavenly Bodies by the Attraction of Gravity which intercedes those Bodies, and almost all the small ones of their Particles by some other attractive and repelling Powers which intercede the particles (*74*, 397).

In the way chemistry overlapped with physics, in an attempt to account for imponderable substances and forces, it became one of the leading sciences, both in Lavoisier's chemistry with his incorporation of "caloric" (*215*, 78-83; *151*, 27), and in the works of others who were critical of his new chemistry. This helps explain the fundamental importance of pneumatics for physics as a whole.

Some background to pneumatics is required before tackling Novalis's views. When the sprawling nature of the combustion debate is made apparent, Novalis's notion of an "experimental calculus" will be seen to be a considered response to the real problems of the science of his time. For his notion of "Experimentencalcul" arises in a scientific context where debate advances through innumerable slight and subtle changes, as much as by reversals and contradictions. An "experimental calculus" was, then, in Novalis's view, particularly appropriate for the pneumatics debate, and would speed up discovery. The summary of the phlogiston debate, which is now to be given, will show how the participants often entrenched themselves, and how Novalis's proposal that phosphorus should be used as a symbolic substance at the same time brings some order to the debate, and also assists in keeping the debate open. Further, as mentioned, the full implications of Novalis's notion of "experimental calculus" for chemistry go beyond the strict pneumatics debate to deal with chemical and physical factors, pointing towards an extension of pneumatics, and an emerging, more complex view of matter. This is discussed in the next section.

In the pneumatics debate of the 1790's, phlogiston still plays a role as an explanatory notion. While it is true that the antiphlogistians had more or less won the struggle in 1790, the debate still carried on into the nineteenth century with alternatives to the oxygen theory, such as nitrogen, water and phlogiston itself (*167*, 49).[15] In the eighteenth century, which was its true age, phlogiston eventually came to mean many things: a substance with negative weight, light, electricity, soot, a fatty principle, the matter of fire and hydrogen (*252*, 87-89; *167*, 53). It was Georg Ernst Stahl (1660-1734) who first evolved the theory of phlogiston.[16] Stahl had in his *Fundamenta Chymiae* (*115*) of 1723 set out to improve the notions of Johann Joachim Becher (1635-1682). Becher held that matter was composed of air, water and three earths, the first inflammable (*terra pinguis*), the second mercurial, the third fusible or vitreous, and it was Becher's *terra pinguis* that Stahl renamed phlogiston. Stahl's emphasis on phlogiston and its use as the base of a theory of combustion initiated a turn away from the three alchemical principles of salt, sulphur and mercury (*252*, 88). This is important for the entire pneumatics debate since a "principle" of combustibility was subsequently to haunt all experimentation in this field. It was only with the acceptance of the concept of energy in the mid-nineteenth century that the need to explain combustion or heat in terms of a substance was no longer felt to be necessary (*252*, 89). Pneumatic theory then both implicitly and sometimes explicitly linked up to deep level matter theory.

Indeed, when Lavoisier put forward his theory of combustion it did not involve oxygen alone. He had to employ some sort of imponderable substance in his theory, but he did not attempt to explain it. He did explain that the increase in the metal's weight was caused by its calcination through oxygen, but he explains oxygen in its natural state as a gas made up of a mixture of an oxygen base with heat and light (*167*, 48; *142*, 131). Lavoisier himself was not the true discoverer of oxygen, for Scheele had discovered *fire air* in the early 1770's (*252*, 107, 105), and Priestley (1733-1804) had already discovered *dephlogisticated air* in 1774 (*252*, 117-121; *185*, 144-145). Lavoisier's experiments on combustion were primarily directed against Priestley's experiment of 1774 and his use of phlogiston in a theory of combustion, for Priestley saw air as an elementary substance (*185*, 145) and his notion of *dephlogisticated air* was based on his belief that the phlogiston had been taken out of the air, and hence to him air was either "phlogisticated" or "dephlogisticated" (*252*, 117-118; *86*). Lavoisier showed that air must be made up of two gases and that the notion of phlogiston was superfluous to combustion, for in his theory it is the oxygen which combines with the metals, in distinction to the phlogistic notion where the metals lose their phlogiston in order to become calcinated. Thus in his experiments of 1777 (*69*, 35; *252*, 128) to prove the role of oxygen in combustion, Lavoisier set out to demonstrate that it was not the phlogiston which had been taken out of the air during combustion, but rather that the oxygen had been withdrawn, and that by extracting the oxygen from the calcinated metal in the second stage of his experiment, he could then in the third step restore the oxygen to the so called *dephlogisticated air* to produce the original atmospheric air (*252*, 128-129; *185*, 145-148). Nevertheless, Lavoisier is in essence arguing against one notion of a principle of combustibility where the matter of fire happens to be called phlogiston and is located in the combustible; while in his own theory the principle of combustibility is bound up with the pure air (oxygen), so that this gas exists, as mentioned, as a base with the heat and light of "caloric".

The antiphlogistic notion of "caloric" or "Wärmestoff" naturally did not escape criticism. The phlogistian Jeremias Benjamin Richter (1762-1807), for example, argued that Lavoisier's heat substance was just as much a fanciful idea ("eine ebenso ungereimte Grille") as phlogiston itself:

denn niemand hat den Wärmestoff abgesondert darstellen und ebensowenig ein Gewicht an ihm bemerken können (*91*, 1, xiv; *167*, 56).

These were strong words from someone who was going even further than Lavoisier in quantifying chemistry, for Richter had undertaken to "mathematize" chemistry in his *Anfangsgründe der Stöchyometrie oder Meßkunst chemischer Elemente*.[17]

Strong opposition to the antiphlogistians came from Richard Kirwan (1733-1812) who believed that phlogiston was hydrogen. This view was held by many scientists, such as Cavendish (the first to suggest this idea), Priestley, Bergman, Delamétherie, Crell, Wiegleb and Hermbstädt (*167*, 57). Priestley, although a phlogistian, did not become as involved as Kirwan in the polemics of the pneumatics debate (*167*, 61). Kirwan quite properly pointed out some of the anomalies of the antiphlogistians, but did however recant in 1791 and took the French side. Kirwan attacked the antiphlogistians on the subjects of affinity, the composition of acids, and the composition of water. Kirwan believed that combustion involved not only oxygen but also hydrogen (i.e. phlogiston). According to Kirwan, in combustion the metal lost its phlogiston/hydrogen, with which the oxygen formed "fixed air", and the calcinated metal was a mixture of metal, oxygen and phlogiston/hydrogen:

Meiner Meynung nach verlieren die metallischen Substanzen durch ihre Calcination ihr Phlogiston, welches weiter nichts ist, als reine brennbare Luft im verdichteten Zustande; und zugleich verbinden sie sich gemeiniglich mit der fixen Luft, die während der Oxydation erzeugt worden ist (*65*, 335; *167*, 59).

He also maintained that water was an element and used strong arguments based on chemical affinity to discount the antiphlogistic view that water was a compound. The composition of water was important to the antiphlogistians since it fitted into the oxygen based theory of combustion; it explained to them why when metal oxides were heated with hydrogen, metal and water were produced, and why when iron was heated with water, hydrogen was produced, and why when metals were dissolved in acids hydrogen was produced (*167*, 58). Since Kirwan believed that water was an element, the hydrogen had to come from the iron when iron was heated with water (as mentioned, metals existed as a base with hydrogen/ phlogistan in Kirwan's view). He argued that, if as Lavoisier maintained, carbon had a greater affinity for oxygen than iron, then no hydrogen should be produced when iron and water were brought together at normal temperatures, since even over glowing coals no hydrogen arises from water (*167*, 58; *65*, 261). Kirwan further saw hydrogen/phlogiston playing an important role in the theory of acids, in distinction to Lavoisier's notion that all acids contained oxygen. Indeed oxygen stems from the Greek for "generator of acids" (*252*, 132; *215*, 85). Whereas Lavoisier saw all acids as a compound of substances with the base of oxygen, and that metal precipitations in acids were caused by the metal forming a compound with the oxygen of the acid (*167*, 50, 59), Kirwan argued that metal precipitation in acids was due to the metal base's affinity for hydrogen/phlogiston. Thus when metals were dissolved in acids the hydrogen/phlogiston came from the metal and not from the acid (*167*, 59; 64). Here as von Engelhardt remarks "liegt die Grenze der antiphlogistischen und zugleich auch der phlogistischen Chemie, der Sauerstoff- und Wasserstoffchemie" (*167*, 59), for the antiphlogistian notion that all acids were oxygen based meant that metals could only be seen in the light of oxygen, and the phlogistian notions that water was an element, and that combustion had always to involve hydrogen/phlogiston and oxygen, were also not wholly explanatory.

Even before the arrival of the antiphlogistic theory, attempts were made to explain the increase in weight during combustion. H.Th. Scheller (in 1757) and J.P.Chardenon (in 1763) explained phlogiston as a negative weight (*252*, 55). Friedrich Albrecht Carl Gren (1760-1798) took up a similar stance. He equated phlogiston with heat and light and explained the increase in weight through the imponderability of heat and light:

Denn da der Stoff der Wärme und des Lichtes keine Schwerkraft, in Vergleichung der übrigen Körper, hat ..., so muß auch das Phlogiston, welches aus beyden zusammengesetzt ist, sie nicht besitzen. Es muß also auch das Phlogiston, wenn es mit einem schweren Stoff in Verbindung tritt, das absolute Gewicht desselben vermindern, und umgekehrt, es muß dies absolute Gewicht eines Körpers wieder zunehmen, wenn das Phlogiston abgeschieden wird (*44*, 1, 219; *167*, 55-56).

Gren did, however, accept the antiphlogistian theory but still sought to combine the two schools of thought, using the ideas of Richter and Leonhardi (*167*, 56; 45; 46). Richter combined the notions of phlogiston and "caloric", explaining combustion as an attraction of the two material bases (i.e. metal and oxygen) and a corresponding attraction of phlogiston with the "caloric" of the oxygen, which united causing the light and fire (*252*, 89).

The theoretical complexity of the phlogiston debate, one could say, could have benefited from a methodological form of mediation, such as Novalis's, to prevent the participators entrenching in camps and blocking themselves off from open inquiry. A form of chemical inquiry was needed with broader parameters and also with a methodology that allowed for theoretical variance, so that the chemical debate would not just be reduced to the cases of phlogiston versus oxygen.

Now Novalis's notion of concrete theory and calculus will be examined with reference to the strict pneumatics debate in the 1790's, which, for the most part, is a debate over which gas causes combustion. Later the possibilities of a broader pneumatic and chemical debate will be considered. To begin with, though, we will now see how phosphorus could be understood as an image of the pneumatic debate: Novalis chose it, because, in his view, it offered the chance of improving pneumatic theory by offering up an open position. The implications of his remarks on phosphorus are that it should be seen as the commonly used substance it was, and, as such, it should be seen as the consensual base of a phenomenal calculus for open debate.

Novalis was well versed in "the jungle of the Theory of Phlogiston" (*252*, 84). Picking one's way through his natural philosophical notes the reasons for his suggestion of an "experimental calculus" for the pneumatics debate can be pieced together. Examples of works he made notes on will also show some further developments in the pneumatics debate in the 1790's.[18]

Novalis knew of Mrs. Fulhame's view of combustion. She argued against both camps in the debate, as is manifest in the title of her work of 1774: 'An essay on Combustion, with a view to new art of dying and painting. Wherein the phlogistic and antiphlogistic hypotheses are proved erroneous' (*34*). Novalis, however, had as sources the extract of her work in J.C.Delamétherie's (1743-1817) *Journal de physique* (*33*; *61*) of 1798 which he made notes on (*N*, 3, 76), and Ritter's review of her work in 1798 in Scherer's *Allgemeines Journal der Chemie* (*5*; 93), which Novalis also refers to (*N*, 3, 183, 185). Mrs. Fulhame explains combustion as the decomposition of water through double elective affinities: combustion was thus linked not to hydrogen or oxygen alone but to water, and phlogiston is rejected. Ritter sums up her work:

Das allgemeine Resultat aller vorigen Untersuchungen ist demnach, um das Ganze zuletzt mit Einem Blick zu übersehen, folgendes: Wasser ist sowohl zur Wiederherstellung (Desoxydation), als zur Oxydation der Körper nothwendig, und wird immer bey diesen Operationen zersezt. Alle in dem angezeigten Werk enthaltene Versuche zeigen es, daß die Weise, auf welche entzündbare Körper die Wiederherstellung bewirken (desoxydiren), in allen gleich ist. Kein Körper wird oxydirt, ohne daß gleichzeitig ein anderer desoxydirt werde, und umgekehrt. Auf diese Weise erhält die Natur ein Gleichgewicht von Kraft, zwischen entzündbaren und oxydirten Körpern, und verhütet die Rückkehr des ursprünglichen Chaos. Bey *jedem Verbrennungsproceß* ist zu unterscheiden: *Oxydation* d.i. Vereinigung des Sauerstoffs mit entzündbaren Körpern und - *Desoxydation* d.i. Wiederherstellung oxydirter Körper zu ihrem entzündbaren Zustand. Und da bey jedem Falle der Verbrennung *Wasser zersezt* wird, und ein Körper durch den Sauerstoff des Wassers oxydirt wird, indeß der andere zu seinem natürlichen Zustand durch den Wasserstoff der nämlichen Flüssigkeit wieder hergestellt wird, so folgt, daß der *Wasserstoff des Wassers* die einzige Substanz ist, welche Körper zu ihrem entzündbaren Zustande herstellt; daß der *Sauerstoff des Wassers* der einzige ist, durch welchen, und demnach *das Wasser die einzige Quelle* ist, *aus welcher entzündbare Körper* *oxydirt werden*; daß also in keinem Falle die *Verbrennung* durch einfache, sondern in jedem *durch doppelte Wahlanziehung bewirkt* wird (*93*, 441-442).

Novalis was further aware of J.F.A.Göttling's (1755-1809) notion that combustion was caused by nitrogen. He made notes on the sections of the article where the antiphlogistians Fourcroy (1755-1809) and Vauquelin (1763-1829) damningly criticized Göttling in Scherer's *Allgemeines Journal der Chemie* of 1798, 'Prüfung der über das vorgebliche Leuchten des Phosphors in Stickstoffgas angestellten Untersuchungen':

Es schien seit einigen Jahren, daß die Antagonisten der französischen Chemie von allen Seiten besiegt wären, und daß es weiter keinen Zweifel mehr an der Wahrheit dieser Lehre gäbe, der schwachen Angriffe ungeachtet, die noch von Zeit zur Zeit gegen sie gerichtet wurden, als Herr Göttling, Professor der Chemie zu Jena, in Jahr 1794 eine Schrift unter dem Titel: *Beytrag zur Berichtigung der antiphlogistischen Chemie auf Versuche gegründet*, herausgab, wodurch er die Grundlage dieser Lehre zu untergraben und eine beynahe völlig entgegengesetzte an ihre Stelle zu setzen hoffte. Daraus, daß der Phosphor, wenigstens in einer niedern Temperatur, im Sauerstoffgas nicht leuchtete und nicht merklich brannte; daraus, daß besonders derselbe verbrennliche Körper ihm Licht in dem Stickstoffgas darbot; daraus schloß er, daß dieses letzere zur Verbrennung geschickter als das andere sey (*31*, 494).

Claude Louis Berthollet (1748-1827) also believed that nitrogen caused combustion, but he too, as Fourcroy and Vauquelin write in the same article, came round to the antiphlogistic theory:

Demungeachtet hielten wir es für nothwendig, die Versuche des Herrn Göttling zu wiederholen, und die Fehler, die er uns begangen zu haben schien, in ihrem Ursprunge aufzusuchen. Dem Institut ist bereits die Arbeit des Bürgers Berthollet über denselben Gegenstand mitgetheilt worden. Unser College hat geglaubt, daß der Phosphor sich im Stickstoffgas, und nicht im Sauerstoffgas auflöse; daß er in diesem sich entzünde, nachdem er sich in jenem aufgelöst habe; daß auf diese Art die langsame Verbrennung in atmosphärischer Luft bewirkt werde; er hat aus seinen Beobachtungen zwey sinnreiche Ansichten gezogen, die eine über Eudiometrie, durch die langsame Verbrennung des Phosphors, die andere über die Zusammensetzung thierischer Stoffe. Ob er gleich bekannt gemacht hat, daß er Phosphor im Stickstoffgas leuchtend gesehen habe, wie Herr Göttling, so hat er doch seitdem eingesehen, und zwar nach den ihm gezeigten Beobachtungen, daß dies von einer kleinen im Stickstoffgas enthaltenen Quantität Sauerstoff herrühre; dieses Stickstoffgas war aus Ammoniak durch Salzsaüre gezogen worden (*31*, 498).

Given that staunch figures such as Berthollet and Priestley had argued against the antiphlogistians, and the concomitant variations on combustion theory, Novalis's wish for a "Muster des Experimentirens" indeed seems not unreasonable. For taking a key substance such as phosphorus as a phenomenal base about which the differing theories could operate using analogies or a "phenomenal" calculus, and in viewing phosphorus as a symbol per se of pneumatic theory, acting as the analogy or notation linking theory and phenomena, implied leaving the pneumatic debate open until a broader more explanatory theory was obtained. A characteristic example of his open views on the debate and his interest in phosphorus is found in a comment Novalis jots down after his notings from Foucroy and Vauquelin. After reading their comments on Berthollet, he immediately remarked upon the very work on eudiometry by Berthollet that they referred to (a detailed account of eudiometry and the use of phosphorus is given below):

Die langsame Verbrennung des Phosphors nach Berthollet, der beste eudiometrische Process (*N*, 3, 188; *12*).

Novalis does not, however, give up the notion of phlogiston. Almost two years later, in 1800, he speculates over phlogiston in the context of excitability and the structure of a natural hierarchy:

Oxyd[ation] Verminderung der Personalitaet.
Phlogiston = Geist.
Dem Geiste ist *Ruhe* eigenthümlich.
Das Schwere rührt vom Geiste her.
Gott ist von unendlich gediegenen Metall - das Körperlichste und Schwerste aller Wesen.
Die Oxyd[ation] kommt vom Teufel ...
Luftvernichtung ist Herstellung des Reichs Gottes ... (*N*, 3, 659).

Here the driving force behind the universe, God, is equated with an infinite mass of enormous energy potential (phlogiston).[19] In Novalis's pathological and combusting world there is a struggle between energy/phlogiston and oxidation. The process of combustion is part of a moral process, hence substances such as phosphorus or phlogiston were elevated to symbols of a spiritual quest. In this manner Novalis views the chemistry of his time as an essential part of his whole project of natural philosophical productivity, whose goal is to unite man's consciousness with the purposiveness of the natural world. Thus, in an extended sense, his programme of phenomenal calculus for the sciences is one of the paths which will lead to the Golden Age, a path upon which the moral scientist will ever better to "plasticize". This is the upper aim of Novalis's project, but, as will be shown, Novalis offers a wealth of comments dealing with lower level issues, which are closer to the activities of the sciences of the time.

The examples above show that Novalis was generally well informed on the combustion debate; some further examples given now will reveal just how much of a central role phosphorus itself played in the debate. It will be shown that the scientific context itself gives grounds for Novalis's "experimental calculus", and his meaning of a "Combinatorik".

A study of the works Novalis read shows that there were many reasons for the use of phosphorus as an analogical tool and as a consensual term in the pneumatics debate of the 1790's. Firstly, in the experimental context the important theoretical issues often depended upon whether or not phosphorus burnt under certain circumstances. Since it was used so frequently, it must have appeared as a touch-stone for the verification of the various pneumatic theories, i.e. acting as a powerful analogy of the link between theory and nature, between man's beliefs and the outside world. A direct reference to the particular significance of phosphorus for pneumatic experimentation occurs in Ritter's review of Mrs. Fulhame's work. Ritter draws a parallel between the combustion theory of Mrs. Fulhame, evinced in her experiments on the varied solutions of metals and phosphorus and their precipitants, and the combusting rod ("Stange") of phosphorus:

> Die Versuche mit Phosphor- und Metallauflösungen in Aether, Weingeist und Wasser beweisen die Wahrheit dieser Erklärung, und zeigen, daß, wenn ein Metall das andere niederschlägt, es wie eine Stange Phosphor wirkt, nämlich das Wasser zersezt (*93*, 440).

For Ritter, phosphorus is the image of Mrs. Fulhame's "water" chemistry, and, it would appear, an almost symbolic analogical key to her science. For Ritter's remark does not just touch on her experiments with phosphorus, but on all her experiments and views: notably, her ideas on fermentation (*93*, 435-6), on light

(*93*, 433), on meteorology (*93*, 436-437), on the combustion of metals through fire and electricity (*93*, 434), and on the combustion of carbon ("Kohle") (*93*, 432). Thus it can be seen how Novalis bases his view of phosphorus on the way the substance was understood in his day in scientific practice.

There are also more examples in what Novalis read of the way phosphorus was understood as a phenomenon which could act as an analogy and thus give grounds to his idea of phosphorus as key element of notation. It could be taken to argue for quite different notions of combustion. Thus, Mrs. Fulhame, to support her view of combustion, maintained that phosphorus only burned in damp air. In his review Ritter also cites Bergman (1735-1784) and Spallanzani (1729-1799) to support this view of phosphorus:

So verbrennt nach ihr [*Mrs. Fulhame*] auch der Phosphor in der Lebensluft nur, in sofern sie feucht ist, und eine Beobachtung von Bergmann [*sic*] spricht abermals für diese Meinung ... (*93*, 435).

To this Ritter adds in a footnote the remark that Mrs. Fulhame cited from Bergman, and himself cites Spallanzani:

"Der Phosphor verzehret sich sehr langsam mit der Lebensluft ohne Hülfe einer äußern Wärme; wenig oder nichts wird aber verzehret, wenn kein Wasser vorhanden, so durch eine doppelte Attraction die Zerlegung befördert." Auch *Spallanzani* sagt: "Wenn die gemeine Luft sehr trocken und von Quecksilber eingeschlossen ist, so geht die Verbrennung des Phosphors in gewöhnlicher Temperatur sehr langsam von statten. Licht und Wärme sind dabey fast unmerklich" (*93*, 435-436).[20]

Here, water is seen as the fundament of combustion, and phosphorus as the proof of this; the next examples will show how phosphorus is used to support entirely different theories of pneumatics.

Adam Wilhelm von Hauch used phosphorus in an essay which Novalis may have read since it was published in Gren's *Neues Journal der Physik* of 1795. It was entitled 'Beschreibung einiger mit Phosphor angestellten Versuche in Hinsicht auf die Wahrscheinlichkeit der Lehre von den Bestandtheilen des Wassers, nehmlich Sauerstoff und Wasserstoff', and in it von Hauch argues for the antiphlogistians and their view of water. Von Hauch comments on what he thinks is the significance of his work:

Die Lehre vom Wasser ist ... der Hauptgrundstein, auf welchem die ganze neue französische Lehre der Chemie beruht und wodurch ihre Beybehaltung oder Verwerfung bestimmt wird (*49*, 29).

Again phosphorus plays the role of "arguing phenomenally" for their theory.

Fourcroy and Vauquelin, arguing against a nitrogen theory of combustion, demonstrate both that phosphorus combusts in atmospheric air (as opposed to pure oxygen), and that oxygen is a more powerful combustant than nitrogen:

... es ist klar, daß die langsame Verbrennung des Phosphors in dem Sauerstoffgas erst bey 22° ihren Anfang nimmt; man weiß übrigens, daß seine schnelle Verbrennung nur bey 32°, und wenn er schmelzt, statt finde (*31*, 500),

and further,

Daß die gleichzeitige Gegenwart dieser beyden Gasarten [*oxygen and nitrogen*] zur langsamen Verbrennung des Phosphors, und zu seiner Verwandlung in phosphorigte Säure bey Temperaturen unter 20° unentbehrlich ist, und daß dies der Grund ist, warum er in atmosphärischer Luft, ungeachtet seiner niedern Temperatuur, und bis zu einigen Graden unter Null langsam brennt, indeß er sich unter 20° in Sauerstoffgas blos auflöst (*31*, 505).

Using alternate mixtures of phosphorus with gases, and introducing the gases into a bell jar with phosphorus and another gas, Fourcroy and Vauquelin demonstrated that oxygen and its mixtures above all caused the strongest combustive effects. The combustion in the experiments and their theory hinged around the touchstone of phosphorus. For they remarked on:

der sonderbare Unterschied, welchen die Flamme des Phosphors zeigt, wenn Phosphor-Stickstoffgas in Sauerstoffgas, oder Sauerstoffgas in Phosphor-Stickstoffgas gebracht wird (*31*, 512).

This comment refers to their fourth experiment, where they describe the more spectacular effect of the combustion of the phosphorus-gas mixtures in oxygen as opposed to nitrogen:

... aber das Licht war weit stärker, da wir ein Bläschen nach dem andern von dem Stickstoffgas, worin der Phosphor gewesen war, in Glocken voll Sauerstoffgas gehen ließen. In diesem leztern Falle war der ganze Recipient voll von einem bläulichen Lichte, indeß in dem ersteren derselbe [*i.e. "Sauerstoff" in "Phosphor-Stickstoffgas"*] weit schwächere Schimmer gleichsam in dem einzigen Punkte der hinzugesezten Bläschen von Sauerstoffgas concentrirt war (*31*, 501).

The varying reactions of phosphorus (or as in the above experiment of the phosphorus-gas mixtures) are the "phenomenal" arguments for the proof that oxygen is a more powerful combustant than nitrogen. A further example from Fourcroy and Vauquelin again shows the analogical use of phosphorus. Novalis noted how Fourcroy and Vauquelin applied the properties of phosphorus analogically to other substances:

Fourcroy schließt analogisch vom Phosphor auf ähnliche *Auflösungen* des Schwefels, der Kohle etc. ... in den genannten Luftarten bey niedriger Temperatur (*N*, 3, 188; *31*, 513).

All these examples show a "Calcül" in Novalis's sense of a fundamental "experiment" of the mind which fixes phosphorus as a symbol in an inner logic of the imagination, and the consequent development of theory based around experimentation with phosphorus. It can be seen that Novalis, through his idea of a "phenomenal" calculus, attempts to provide a methodological basis for this sometimes conscious, and other times tacit use of analogy by the scientists of his time.

Phosphorus was further employed as an analogical tool in eudiometers for measuring the composition of air. Here, phosphorus is used in the quantitative sense of "Calcül", providing the base for a "mathematization" of the air. Here, too, lie grounds for Novalis's interpretation of the pneumatics debate, for the quantification can also be viewed as being based upon a phenomenal calculus which employs phosphorus as the key to its notation. Novalis was well informed in the area of eudiometry and pursued its development keenly, as he wrote:

Priestley - Erfinder des Eudiometers. Er hat durch *Salpeterluft* - Scheele durch *geschwefeltes Eisen* - andre (Reboul) durch *Phosphor* - Humboldt durch *Schwefelleber* den Oxigènegehalt der atm[osphärischen] Luft zu erforschen gesucht (N, 3, 39).

Novalis refers here to Reboul's eudiometer which he could have read about in Gren's *Neues Journal der Physik* of 1795 (*89*). Novalis could also have known of Gren's article on a phosphorus eudiometer where Gren writes:

So haben wir an der allmähligen und langsamen Verbrennung des Phosphors, oder seinem Zerfliessen, bey der mittlern Temperatur, das vollkommenste eudiometrische Mittel, und sind im Stande in der zu prüfenden Luft auch den kleinsen Rest des darin befindlichen Sauerstoffgas wegzuschaffen (*47*, 364).

Here, clearly, Novalis could have found further substance for his notion that phosphorus was a paradigmatic and consensual term for inquiry.

Phosphorus, however, did not go uncriticized as an eudometric substance, since it did not entirely combust all the oxygen in the apparatus, as for example Humboldt (1769-1859) points out in a work on which Novalis also made notes (*N*, 3, 198):

Bey meiner mehrjährigen Beschäftigung mit der genauen Analyse der Atmosphäre und mit den verschiedenen Eudiometern, von denen ich die Grenzen zu bestimmen suche, bis zu welchen sie irre führen können, fand ich, daß das Stickstoffgas, welches man bey der Zerlegung der Atmosphäre durch den Phosphor erhält, sehr oft einen Antheil Sauerstoff enthält, den man ihm durch keine Verwandtschaft der saürefähigen Basen entziehen kann (*55*, 577).

Notwithstanding such reservations, it can be seen that phosphorus is once again at the forefront of the pneumatic debate, this time literally as an instrument for "calculating" the air.

*2.2. Phosphorus's role in practical social knowledge and in the dramatic aesthetics of scientific productivity.*

Undoubtedly important to Novalis's notion of "Experimentencalcul" is also the fact that phosphorus was a spectacular substance. It was an analogical tool that most easily attracted attention, and so quite naturally became a symbol in an inner language or logic of the imagination. Consequently, for Novalis, phosphorus would have joined the scientific stage as a figure to become part of the spectacle in a symbolic theatre of "experimentation":

Über das Theatralische des *Jahrmarckts* und des *Experimentirens* - Jede Glastafel ist eine Bühne - ein Laboratorium - eine Kunstkammer ist ein Theater ... (*N*, 3, 452).

The symbolic theatre of "experimentation" is an important social aspect of Novalis's rhetoric of experiment. In broad terms, such a stance to experimentation conflates "Art and Life", "Appearance and Reality", and provides a profound social comment on science. The dramatic rhetoric of experiment enhances those notions already bound up in Novalis's idea of experiment: consensuality and cognitive gain. The consensuality of experiment is clearly expressed in the involvement of the audience in a lecture hall. The epistemology of experiment is manifest in the experiential and symbolic transfer of knowledge in performance. Both of these aspects of the dramatic aesthetics of scientific productivity come together in the open, public performance and demonstration of scientific theory. The stage performance is transferred to the mind. In the way Novalis's notion of experiment harks back to the use of experience in memory systems, there is an element of this dramatic rhetoric of experiment that may perhaps recall something of the Renaissance memory theatres of Giulio Camillo and Robert Fludd.[21] At a broad epistemological level there is a link in their ideas of theatre in terms of a combination of images and symbolic knowledge. However, I cannot find a genuine link between Novalis and Renaissance theatre of memory, although Novalis does mention Fludd in a letter to Caroline Schlegel where he asks August Wilhelm Schlegel for copies of the works of Helmont and Fludd (*N*, 3, 86; *N*, 4, 261).[22] Whether this empirical link exists or not, Novalis none the less continues the Renaissance tradition when he suggests that his idea of concrete notation can be used in a social way in the lecture hall.

Novalis's sensual-imaginative approach to theory could further be likened to a Socratic model of inquiry. The theatre or lecture hall would provide the modern place for a broad audience and the possibility for a debate at many levels. The notion of as broad a debate as possible is suggested by the linking of "experimentation" with the market ("Jahrmarkt"). There are obvious connotations of open discussion and argument, and perhaps a radical Socratic "experimental" theatre is invoked where the audience participates, and the demonstrators have to haggle for theory. They would have to give answers to their theories through discussions, recalling their deep "innate" beliefs. Attention would be focussed around a phenomenon and different theories would be put to test through direct debate. If scientific debate was as hectic as at the market, and if people were thrashing out theories in heated debate, some life or genuine feeling for the sciences would be brought about on a large scale. The spectacle of the theatre affords a demonstration of a Socratic moral concretization of knowledge. The entertainment of the spectacle literally raises the audience's attention for a questioning of knowledge, forcing the audience to a practical awareness and, importantly, to come, in a Socratic sense, to a better understanding of why they hold a particular theory. By answering the "why", they would arrive at a purposeful, moral understanding of their beliefs and knowledge. Indeed, Novalis's modern Socratic model of inquiry, instead of reducing science to statements about nature, offers a model of inquiry as a whole, including man, his institutions, and Nature. Such a model does justice to how ideas and discoveries come into being: theory evolves from tireless discussion, from the return to experience, and from the debate revolving around certain phenomena.

Novalis's notion of an "experimental" theatre finds some anticipations, although not in his full sense, in the science of his day. Consider the remarks that Fourcroy and Vauquelin make on the entertaining and pedagogic qualities of one of the experiments involving phosphorus. Here, the stage is a lecture hall, and the players are nitrogen, phosphorus and oxygen. Phosphorus and oxygen take the lead roles in the stunning display of a blue flame in the darkened lecture hall. The show is not pure entertainment, for it is also meaningful for Fourcroy and Vauquelin, since behind the "experiment" lies the entire antiphlogistic theory. In Novalis's terms, naturally, we see here a form of concrete dialectics that mediate between theory and phenomena, sparking off an inner language or logic. Fourcroy and Vauquelin write:

Bey jedem Bläschen vom Stickstoffgas, welches in das mit Phosphor gemischte Sauerstoffgas übergieng, erschien eine bläuliche Flamme, welche den ganzen Raum der Flasche füllte. Dieser Versuch bot im Dunkeln ein Schauspiel dar, das sehr schön und beynahe den zarten und dünnen Funken ähnlich war, welche man aus dem elektrischen im leeren Raum verbreiteten Fluidum erhält; man könnte es dem an die Seite stellen, welches man in den physikalischen und chemischen Vorlesungen zeigt, um die Wißbegierde und Aufmerksamkeit der Zuhörer zu reizen. Er beweißt, wie die vorhergehenden, daß die Gegenwart des Sauerstoffs nöthig ist, um den Phosphor leuchtend zu machen (*31*, 502).

Explicit, here, is the notion that a concrete experiment raises the attention and interest of an audience. A lucid demonstration will always assist a theory, and in the light of the warring scientific factions this may well have been important. However, from Novalis's point of view, the demonstration is not only a test or a proof of a particular theory in the pneumatics debate. Since the field in his opinion was open, he preferred a recall to the very essence of demonstration or show, that of captivating the audience and impressing a phenomenon upon their minds, and to use this impressed symbol in further "experimentation" as the basis of an "experimental" calculus.

A further example of the theatricality of phosphorus should, perhaps, be given to show the contemporary awareness and interest in "entertainment" chemistry. P.J.Macquer (1718-1784) comments on phosphorus in this light in his *Chemisches Wörterbuch*. Macquer's remarks on "eine unzählige Menge belustigender Versuche" with phosphorus show that he clearly envisages a form of experiment as entertainment. Naturally, Novalis's view, unlike Macquer's, carries both social and theoretical implications. Macquer further comments on the potential of phosphorus for "surprise" entertainment, were it only less well known; Novalis, with his different interests, sees it an exemplary substance precisely because it was commonly known, and therefore had potential for open debate. Here, then, are the experiments which Macquer describes:

Wenn er [*phosphorus*] übrigens bloß in der Anzahl dererjenigen Sachen bleiben müßte, die nur das Auge belustigen, so würde er allezeit in dieser Klasse den ersten Rang mit behaupten. Man macht mit dem Phosphor eine unzählige Menge belustigender Versuche, welche das größeste Erstaunen erregen würden, wenn diese Substanz weniger bekannt wäre. Mann schreibt z.B. an die Mauer eines dunkeln Ortes mit einem Stängelchen Phosphor, und die Schrift läßt sich sogleich als feurige

Buchstaben lesen ...Man löschet einen Wachsstock aus, und zündet ihm augenblicklich dadurch wieder an, daß man an die noch warme Schnupfe die Spitze eines Messers hält, an welche man ein kleines Stück Phosphor mit etwas Unschlitt angeklebt hat. Hierher gehören auch die selbstzündenen oder phosphorisirten Kerzen ... Es sind dünne in zugeschmolzenen Glasröhren enthaltene Wachsstöckchen, deren mit Zimmt- Nelken- oder Wachsöl oder mit geschmolzenem Wachse oder mit geschmolzenem Benzoe und Schwefel benetzte, sodann in Kampher- und Schwefelpulver, oder in feinem Salpeterstaub, oder Schwefelpulver allein herumgedrehte Schnuppen in etwas geschmolzenem Phosphorus, welcher in dem einen Ende der zugeschmolzenen Glasröhre enthalten ist, getaucht worden, und nachdem die Glasröhre an einem angeschliffenen Orte zerbrochen worden, einigemal in dem Phosphor schnell hin und her bewegt wird, da sodann die hervorzuziehende Kerze sich sogleich entzündet (*71*, 4, 561).

Macquer provides an insight into the fascinating effects created with phosphorus, but gives his "theatre" no theoretical underpinning. That the entertaining qualities of phosphorus which he refers to were indeed common knowledge can be seen again in Novalis's own reference to what can best be described as phosphorus "fire-crackers":

Feu portatif - *Phosphorauflösung in Nelkenöl*. Turinerkerzen -
Wachs und Phosphor - Baumwolle hineingetaucht - und diese in luftleeren - oder verschloßnen Gläschen aufbewahrt (*N*, 3, 45).

Even this shorthand description of the phosphorus concoction, "Feu portatif", is quite different from Macquer's, in that it sounds emblematic. In these early forms of "fire-crackers", Novalis was already searching for a way to harness entertainment to deeper theoretical ends. The burning image of phosphorus juxtaposed with the emblematic name, "Feu portatif", can be seen as part of the process whereby, for Novalis, phosphorus could become a symbol for combustion, in accordance with his notion of a method of open inquiry which uses symbols within an "Experimentencalcul".

In conclusion, a reminder of the value of social issues in Novalis's notion of inquiry is called for. In general, the social aspects of Novalis's views on inquiry, such as the dramatic rhetoric of scientific productivity, the Socratic method, or the idea of a "symbolische Physik", significant as they are, do not take up the central role in his view of knowledge. Arguably more central, as mentioned, are the epistemological factors concerning the individual and inquiry. These are, of course, also present in Novalis's idea of social knowledge, but are in many ways a prerequisite for his notion of social knowledge, and are thus more the primary determinants of his notion of knowledge and inquiry.

### *3. Phosphorus and matter theory: the breadth of the possible programme for natural philosophical productivity.*

### *3.1. The ramifications of the pneumatic debate for matter theory: the possible extension of Novalis's programme.*

The previous section has attempted to look at phosphorus primarily within the strictly pneumatic sphere, the study of gases; but, naturally, pneumatics meant more than, for example, the discovery of oxygen as the cause of combustion. It now needs to be considered why Novalis wished to keep the pneumatic debate open, why he wished to extend pneumatics into deeper physical theory, and why he preferred, for this reason, a "Muster des Experimentirens" to a fully fledged pneumatic theory. The initial remarks on "Chemie" in this chapter indicate how important chemistry was, and how important pneumatics were, for the sciences of the time. Widely divergent views of chemistry depended upon pneumatic theory. Before turning our attention to phosphorus in this context, an overview of Novalis's stance to the chemistry of his time should be given.

Novalis took a highly historical view of the 1790's pneumatics debate. He saw the new chemistry as important, not so much for the discovery of oxygen and its role, and, as mentioned, certainly not because of Lavoisier's programme for an elemental chemistry, but because of the very factors which played so great a role in the background to Lavoisier's discovery itself, such as the gain of weight in combustion and heat (Lavoisier's "caloric"). The chemical revolution came about, in Novalis's view, because of a fundamental change in chemistry's programme of inquiry, which entailed a shift away from the traditional chemical agenda to the study of forces, and to that of the "invisible" matter of air. One could surmise from the following remark of Novalis's that, in his opinion, the real chemical revolution had taken place before Lavoisier. Further, the seemingly unconnected items of Novalis's examples make it appear that Novalis saw the cause of the advancements made in chemistry in a kind of "calculus" or "Combinatorik" between chemistry and other areas of inquiry:

> Die Chymie hat Fortschritte gemacht sobald sie angefangen hat Rücksicht auf die mit den chymischen Phaenoménen verwandte und verbundene Phaenoméne andrer Naturkräfte zu nehmen - z.B. auf Schwererwerdung - Luft - Electricitaet - etc. (*N*, 3, 86).

Clearly, even before Lavoisier, investigators had been observing those phenomena which were related to strictly chemical changes and the forces of these related phenomena. As an example, Novalis explicitly mentions the increase in weight during combustion ("Schwererwerdung"). This was, as already discussed, the very crux of Lavoisier's discovery, but before Lavoisier it was a main issue for phlogiston chemistry. Novalis also cites "Luft", which was, historically, an area of inquiry that goes back a long time, namely to Van Helmont (1579-1644) (***252***, 48), but perhaps Novalis is here referring to the experiments of Cavendish (1731-1810) or, more likely, Priestley. "Electricitaet" could refer to a number of things which were common knowledge at the time, but in the context might most likely be related to Cavendish's analysis of air through electricity and his eudiometer, a "firing globe", which "fixed air by electricity" (*252*, 138-9; *18*, 119), by sending sparks. Thus, Novalis's shorthand remark epitomizes certain key issues, encapsulating historical developments in chemistry by concrete symbols. Analysis of the symbols effectively relativizes the importance of the new chemistry. Progress in chemistry is itself also seen as a symbolic procedure by Novalis, in which a "Combinatorik" of various spheres of knowledge was employed.

Another remark of Novalis's makes his stance to French chemistry clearer. Here, Novalis moves away from the antiphlogistic "caloric" to speak of affinity and of electricity or electrochemistry:

> Äußerst merckwürdig ist das Bestreben der neuern Chemie alle Stoffe auf wenig *unsichtbare*, luftige Stoffe zurückzuführen - in der Luft die Mutter aller Dinge zu suchen. Wie die Wärme alles in Luft verwandelt und ein luftiger Körper, vielleicht durch Anziehungskraft zur Wärme - *positive Erwärmung*, die benachbarten Körper *negativ* erwärmt, oder erkältet, freylich nur im Moment des Übergangs - indem er nachher wieder wärmt, so verwandelt die Kälte alles in feste Körper und bringt entgegengesezte Verhältnisse hervor (*N*, 3, 184).

Novalis appears to use the term "new chemistry" to refer to Lavoisier's revolution, and also to point beyond the latter to the open pneumatic debate. Thus, from Novalis's point of view, even Lavoisier's chemistry occupied a place in a wider historical programme: a programme that was not engaged in searching for a system based upon the gas oxygen, but was inquiring into more general issues of a matter theory.

Indeed, Novalis traces the new chemistry's interest in air to point to developments in pneumatics that went beyond Lavoisier's chemistry, and led to early attempts at defining energy. The central concept Novalis exploits is that of affinity:

Sehr bedeutend ist die Frage - ob es nicht Stoffe giebt - die so große Empfindlichkeit fur die Wärme - eine so große Anziehungskraft gegen sie haben - daß sie nicht einmal in Luftförmiger Gestalt *beharren*, sondern eine noch fähigere, bindendere Form in Beziehung auf Wärme für immer haben - jedoch tausendfache Verbindungen eingehn - Verbindungen, in denen wir die vorzüglichste Quelle der Wärme, so wie in ihren Entstehungen die Hauptquelle der Kälte suchen müssen. (Licht, El[ektricität], Nervenaether etc.) (*N*, 3, 185).

In 1798 Novalis had to speak of "Stoffe" and "Anziehung", but if one considers the dynamics of the process he envisages it is apparent that he is referring to "Stoffe" which do not correspond to traditional elements or to the antiphlogistic substance "caloric". His view of substance is, rather, philosophical, and approximates to what would today be called matter and energy. Although Novalis still breaks these "Stoffe" down in terms of "Anziehungskraft" and "Verbindungen", he is essentially referring to a form of matter which is perpetually engaged in attracting and is a constant source of heat ("eine noch fähigere bindendere Form in Beziehung auf Wärme für immer haben ...", "die vorzüglichste Quelle der Wärme ...").[23] Thus "energy" plays a more fundamental role in Novalis's view of science than do, say, Lavoisier's elements.

Novalis's source for these notions comes, as is revealed by the surrounding comments, from Ritter's review of Mrs. Fulhame's experiments and Ritter's own galvanic experiments. In a preceding remark he observes:

Sonderbar und bedeutend sind ferner die neulich von Ritter bemerckten quantitativen Verwandtschaftsverhältnisse des Oxigèns. Aehnliche Reihen sollte man von jedem Stoffe haben - die Verbesserung der specifischen Wärmeskalen gehört auch hierher ... Die Galvanischen Erscheinungen eröffnen eine unermeßliche Aussicht im Gebiete der Physik.
Der Fulhame Versuche gehören ebenfalls zu den Wichtigen (*N*, 3, 184-185).

The phrase "die Galvanischen Erscheinungen" refers to Ritter's discovery of the parallel between galvanism and oxidation, which was supported by his reading of the link between galvanic processes and affinity. Consequently, it further alludes to the way Ritter interpreted nerve action, or the imponderable "Nervenaether" itself, in terms of electrochemistry and affinity. Ritter's work on galvanism can be viewed as an early attempt at defining "energy", or, as Novalis expresses this, the search for substances where the "vorzüglichste Quelle der Wärme" is to be found. Also in the above remark, following on from Ritter's observations in his review of Mrs. Fulhame's experiments, Novalis suggests the need for a close inspection and quantification of affinities, and an ordering of the effects of heat on different substances. Such a procedure, in his view, could assist in explaining imponderables such as "Licht, El[ektricität], Nervenaether", and in doing so would not analyze substances "elementally", but rather in terms of their relationship, in the more abstract sense of proportionality, to other substances and effects such as heat. In making this point on the erection of chemical "scales" Novalis is affirming, and responding to, Mrs.Fulhame's notion from her "water" chemistry that hydrogen is the basis for a body's ability to be oxidized. In his review Ritter summarizes this:

> ... daß der *Wasserstoff des Wassers* die einzige Substanz ist, welche Körper zu ihrem entzündbaren Zustande herstellt ... (*93*, 441-442).

Indeed, Ritter goes far to stress that this principle of combustibility, hydrogen, is a universal and a more important one than Lavoisier's oxygen. It enables all combustion, and is the lightest substance. Of all substances, it has the greatest capacity, i.e. attraction, for oxygen. Moreover, in arguing for the importance of hydrogen, Ritter's method of analysis exemplifies Novalis's notion of setting up chemical "scales":

> Der Wasserstoff nur also ist es, der wirklich auch aus andern Quellen als dem Wasser, aus jeder andern (sauerstoffhaltigen) oxydirt werden kann. Merkwürdig genug, daß dieser Stoff in der einfachsten sinnlich darzustellenden Verbindung desselben als Wasserstoffgas, unter allen uns bekannten, unsere Waagen mit endlichem Moment in unendlich kleiner Masse, d.i. Fläche sollicitirenden, von uns im praktischen Leben insgemein schwer genannten, oxydirbaren Raumerfüllungen, bey gleichen Umfängen mit den übrigen unter allen gerade derjenige ist, der dieselben mit dem geringsten endlichen Moment sollicitiret, d.i. das geringste specifische Gewicht hat; daß er aber unter diesen oxydirbaren Raumerfüllungen auch diejenige ist, welche bey der Verbindung mit Sauerstoff die größte Menge desselben zur Sättigung erfordert, oder, wie man

diesen Begriff bestimmter ausdrücken könnte, die größte endliche *Capacität für Sauerstoff* hat (*93*, 441-442).

Even though Ritter is using oxygen as the measuring post for the properties of hydrogen, it is still hydrogen which comes away as the more potent principle of combustion, and not Lavoisier's oxygen. Further, and importantly, as Novalis emphasizes, Ritter's technique of querying Lavoisier's dominating oxygen chemistry, is to tackle the question of a principle of combustibility by treating the oxidation of substances proportionally, and by comparing the ability of substances to oxidize. This, as mentioned, is precisely what Novalis meant by erecting various chemical "scales", and, in doing so, oxygen's "elemental" dominance would be relativized.

Ritter then continues, extending the notion of a combustible principle beyond hydrogen to light; he takes up contemporary ideas about light as a substance capable of affinities, a notion which Goethe, for instance, had already speculated on.[24] Goethe had remarked already in 1793 that light is "der reinste, feinste Körper" to have affinity "mit allen übrigen Körpern" (*40*, I, 3, 130; *129*, 82). Ritter himself speculates, that light, in comparison to other substances, has an enormously large capacity for oxygen. Although Novalis and Ritter use differing terminology, they are both referring to chemical affinity. Ritter uses the term "Capacität" which, in the way Ritter uses it, means affinity. He further places the notion of chemical affinity within the wider sphere of attractions and affinity, specifically relating it (after the manner of the age) to gravity:

Aber merkwürdiger noch, (um den Grundsätzen der Verf. getreu zu bleiben,) ist jene Raumerfüllung, oder bestimmter vielleicht: jener gewisse intensive Antheil bestimmter, wo nicht aller Raumerfüllungen, der selbst den Wasserstoff des Sauerstoffs zu berauben, und damit Lebensluft zu bilden im Stande ist, - *das Licht*. Dieser unsere Waagen mit unendlich kleinem Moment sollicitirende, und darum im allgemeinen Gravitationssystem einen Rang höherer Ordnung bekleidende Wirklichkeitsgrund der Licht genannten Erscheinung, dieser, um gleich den andern ein mit endlicher Größe sollicitirendes Produkt herstellen zu können, mußte es seyn, dessen Moment der Capacität für Sauerstoff im Verhältniß zu den übrigen unendlich groß war, um so über das Gebiet aller Oxy- und Desoxydation zu herrschen, und damit durch Verknüpfung an einander grenzender Ordnungen im allgemeinen System der Gravitation, ein Glied in der großen Kette der dynamischen Welterscheinung zu bilden! (*93*, 442).

Indeed, in linking light to affinity, Ritter is not only seeking to explain gravity in terms of chemical affinity, but also bringing another substance, light, into his own notion that Nature was a vast purposive electrochemical circuit ("ein Glied in der großen Kette der dynamischen Welterscheinung").

Behind Novalis's and Ritter's comments lies, as mentioned, the wish to go beyond the confines of the French chemistry, and as the references here to "Wärmeskalen" and "Verwandtschaftsverhältnisse" imply, both Ritter and Novalis were seeking a science of matter based upon proportions, arrangements and quantification. But this was to be a quite different notion of quantified chemistry from that set up by Lavoisier. To Ritter and Novalis it is not so much a question of the weight of a substance, but rather of how substances, in a more philosophical sense, stand in proportion to one another. At points like this, elemental chemistry merges directly with the chemistry of deeper physical theory, and Lavoisier's strictly elemental chemistry is left behind.

It is important to note how useful the notion of affinity was for discussing the imponderables of a deep level matter theory. For affinity positively did supply the inquirer with alternative methods of relating substances to one another, and, as Ritter's and Novalis's comments show, it was possible to explore this difficult area of physics. Their comments reveal the beginnings of an analysis and explanation of imponderables. By contrast, the materialist notion of "caloric" or "Wärmestoff" did not further inquiry in this area. All it did was to replace an older imponderable ("phlogiston") with a new one.

Moreover, although Novalis refers here explicitly to two forms of chemical "scales", those of "Verwandtschaftsverhältnisse" and "Wärme", throughout his writings he alludes to several more. The further "scales" he suggests are part of his programme of constructing a science based upon "wircksame Begriffe", and the nomenclature of the individual "scales" makes up part of his array of "real metaphysical" notions. He lists the following properties and characteristics of substances, with which, in his view, the inquirer should construct "scales":

Härte. Geruch. Festigkeit. Biegsamkeit. Elasticitaet. Cohaerenz. Adhaesion. Schwere. Electricit[aet]. Magnetism. *Chemische Eigenschaften*. Auflösbarkeit. Verbrennlichkeit. Erwärmbarkeit. Opacitaet. Galvanism.

Acustische Eigensch[aften] (*N*, 3, 596).

The note preceding this one once again reveals the importance of affinity for Novalis. It is a crucial force, and possesses methodological significance as a paradigm for the erection of chemical "scales":

Morveaus Buch von den Affinitaeten - seine Tabellen (*N*, 3, 596).

The common method of setting up affinity tables is indeed decisive to his notion of chemical "scales". Moreover, Novalis did not learn of the importance of affinity from Morveau alone, for "Chemie", and its fundamental aspects, pneumatics and affinity, were among the major subjects of interest in his time. Adler, for instance, points out that in 1799 Scherer held lectures aimed at the general public in Weimar, amongst which was his *Kurze Darstellung der chemischen Untersuchungen der Gasarten* (*113*), where affinity was dealt with (*129*, 81). Adler then remarks how, after these lectures, the whole town was overtaken by chemistry, and how a contemporary was led to comment:

Alle Weimaraner und Weimaranerinnen scheinen Chemiker und Weimar ein großer Schmelzofen werden zu wollen (*223*, 269; *129*, 81).

Moreover, Berthollet's complex affinity programme would have been known to those at home in contemporary chemical debate, even though his ideas were first fully published in 1801 (*29*), since he had earlier published several essays on the subject (*253*, 4, 576). Given this social context, and Novalis's knowledge of Scherer, and also of Ritter, who indeed worked for Scherer, assisting in the publication of the *Allgemeines Journal der Chemie*, it is not surprising that Novalis had a particular predilection for affinity theory. The social context, coupled with his Neoplatonic interests in "Sympathie", explains how a "Calcül", in his view, could be erected as the base of a new chemistry, using "real metaphysical" notions such as affinity. The various chemical "scales" he suggests could then be combined to determine the deeper relationships between substances, whereby the concrete notions (such as affinity, "Elasticitaet" etc.) are used to define the key areas of inquiry. This approach to chemistry and the establishment of particular and broader criteria for the analysis of substances bears indeed resemblance to Berthollet's programme. For Berthollet demanded that chemical processes should be investigated bearing a broad range of factors in mind. In 1801 E.G.Fischer summarized Berthollet's range under "Verwandtschaft", "Quantität", "Unauflösligkeit", "Cohäsionskräfte", "Elasticität", "Wärme", "Efflorescenz", and the "Auflösungsmittel" (*29*, 511f.; *129*, 72). Another list of Novalis drew up reveals how he wished to erect "scales", using his notion of "Combinatorik", in a further aspect of his programme of natural philosophical productivity, which would take account of physiological and psychological factors as well, so as to encompass the whole "real metaphysics" of Nature:

> Krystallisat[ions]kr[aft.] Bildungskr[aft] Generat[ions]kr[aft] Irritabilit[aet.] Sensibilitaet. Vorstellungskraft. Deutk[raft]. Intuitionskraft.
> Wie verhält sich die Elektr[izität,] Der Magnet[ism,] Die Wärmekr[aft,] Cohaes[ions]kr[aft], die Bewegungskr[aft], die Schwerkr[aft], Die Elasticität, der Galvanism, die chemische Verwandtschaftkr[aft] (*N*, 3, 662).

Clearly, Novalis's list of factors can be seen as an extension of investigative methods such as those of Berthollet: the chemist's list of factors in the realm of matter is extended to include organic matter and the mind. Thus Novalis's programme can be understood as a reflection of the unity of the Great Chain of Being.

*3.2. The possible extension of Novalis's programme in deflagration experiments.*

Phosphorus occupied a pivotal place in Novalis's understanding of this innovative field of deeper physical theory and the employment of broader chemical criteria. But what grounds did Novalis have for using phosphorus in an "Experimenten-calcul" as part of an extended pneumatic debate? What grounds did he have for calling phosphorus a "Muster" for a deep level matter theory? In the scientific handbooks of the time, and disregarding Mrs. Fulhame's experiments on double elective affinity, one finds less material on phosphorus as an agent of inquiry for deep level matter theory than as a participator in the antiphlogiston debate. However, there was an interest in deflagration ("Verpuffungen"), that is, detonation experiments, in which phosphorus played a role. Novalis directly refers to detonation when he made notes on Delamétherie's (1743-1817) *Journal der Physique* (*22; 61*). He writes:

Platzende Mischungen.
Potasche mit übergesäuerter Salzsäure - Schwefel und Kohle. Plazt schon bey *leisem Druck* (*N*, 3, 74).

Here, no mention of phosphorus is made, but this is the kind of experiment where it might be used. Explicit use of phosphorus in deflagration experiments is found in Scherer's *Allgemeines Journal der Chemie* in an essay entitled 'Neue Beobachtungen über die Verpuffungen der salzsauren und salpetersauren Salze mit verschiedenen Körpern' (*17*; *5*, 1, 604- 624). The contributors, Brugnatelli, van Mons (1765-1842) and Hoyle, all use phosphorus in their experiments.[25] Novalis makes no direct reference to this article, but since he made notes on other essays in Scherer's first volume, he probably read the article, and was certainly aware of the issues it raises, as his remarks on deflagration, which will now be discussed, reveal.

Brugnatelli's opening words in the article convey the significance of these new deflagration experiments, and will help convey how Novalis's ideas fit into their contemporary context:

Ich wußte, daß salzsaures Kali stärkere Wirkungen, als Salpeter mit Kohle und Schwefel gemischt, hervorbringt; daß es durch Stoßen oder Zerreiben mit einer großen Menge oxydirbarer (verbrennlicher) Substanzen verpufft; allein ich hätte die weit stärkern Wirkungen von bloßen salpetersauren Salzen, und sogar von Metallkalken mit Phosphor gemischt und mit einem Hammer geschlagen, nicht erwartet (*17*, 604).

From this opening it is apparent that a shift has occurred from believing that detonation was a property of particular substances to the awareness that deflagration was a far broader issue concerning, perhaps, all of matter. For Brugnatelli, the great surprise is that metal calcs mixed with phosphorus explode. Phosphorus was therefore one of the substances which alerted him to the broader implications of detonation. In Novalis's sense, it performed the function of a symbolic image for Brugnatelli. Moreover, these lines from Brugnatelli offer some further vindication of Novalis's method of inquiry: Brugnatelli does not stop at detonation theory with "Salzsaures Kali". In effect, he uses a procedure akin to Novalis's "Experimentencalcul"; for he expands research into detonation by considering *many* substances. He does not search for a single substance that detonates, but rather looks for the laws lying behind deflagration.

Brugnatelli's method is indeed symptomatic of an attitude of inquiry that looks not for the properties of particular substances, but rather for general aspects of matter theory. Indeed, all the contributors to the article on "Verpuffungen" experiment with a large variety of substances in what could be seen as an informal "Experimentencalcul" based not around a particular substance, but around the concrete detonation. There is little doubting the vividness for the imagination of a notion such as detonation. Further, because the contributors to the article line up experiment after experiment on the chosen subject of deflagration, in a "calculating" manner, their entire enterprise gives the impression of an "experimental calculus". Their method was of course common practice at the time, and the method creates an ordered effect, and usually took the form, as in this article, of a numeric labelling of each experiment, followed by a description of the experiment itself, i.e. "Erster Versuch ... Zweyter Versuch ... Dritter Versuch ... Vierter Versuch ...". To Novalis this numerical order based around some notion or substance would presumably have appeared as a form of "phenomenal" calculus. Novalis would have seen this as a pattern of thought, already employed by practicing scientists, that could be worked into his idea of a general programme of natural philosophical productivity. As regards phosphorus's status in these experiments, one can observe in contrast to the pneumatic experiments that phosphorus is not the main substance used here, but one of many. To be just, then, one cannot regard phosphorus as the one great analogy for deflagration. Phosphorus is, however, one of the important substances in detonation experiments, and so it belonged with other substances and notions in a broad, imaginative inquiry based openly around the notion of deflagration: a phenomenal calculus that seeks to extend chemical theory into regions of physics and that brings together empirical laboratory work and concrete images in the mind. His concept of inquiry alerts one to the notion that the chemical analogy is based upon the assumption that there is a genuine link between theory and phenomena. The process of drawing analogies, and as in this essay on deflagration, the process of compiling and "experimenting" with different explosive substances, is as much sheer laboratory work, as a mediation between the imagination and matter. Here, the concrete notions would include the particularly significant substances used in the experiments, such as phosphorus, and the relevant factors determining the chemical processes.

Regarding the detonation experiments themselves, they treat the broader factors in chemical processes, and, if one examines the article in detail, one can again see how precisely Novalis's explanatory ideas fit his contemporary scientific situation, for the detonation experiments do attempt to explain chemical activity at a deeper level, investigating substances with what Novalis would deem "real metaphysical" notions, such as "Affinität", "Elasticität", "Druck" and "Wärme". In the deflagration experiments here, inquiry essentially focuses itself not on a full combustion process, as has been considered hitherto for the pneumatics debate, but on a partial combustion process, in which the substances are not given the time to combust fully. Instead of completely reacting, the combustible partly combines with the combustant, while the rest of the oxygen of the combustant, to speak in the terminology of the time, becomes "elastic", causing the forceful effects of detonation. Novalis describes the process himself:

*Platzung* ist ÜberwältigungsPhaenomén der VolumsCapacitaet./ Die Wärme dehnt wohl nicht aus - sondern der Körper dehnt sich aus - um die fremde Masse *Wärmestoff* auf der Oberfläche halten und fassen zu können - *Übergewicht der Atmossfäre über den Kern* bewirckt die *mechanische Vergrößerung der Oberfläche* - die Zerkleinung - Platzung (*N*, 3, 82).

In the article in Scherer the contributors use a hammer on various substances to cause a diminishment of the surface area of the substances. In full combustion, as Novalis explains, the substance expands in order to take up the heat; but if the body does not expand, yet is in the process of combusting, and it is not given the chance to combust fully because of the diminishment of its surface area, it explodes ("die Zerkleinung - Platzung").

Brugnatelli concludes that the strike of the hammer sets the particles in motion, thus allowing their natural affinities to operate:

Der Schlag des Hammers ist nöthig um die Bestandtheile der Körper in jene Bewegung zu versetzen, in welcher sich die Affinitäten thätig beweisen (*17*, 609).

Van Mons, in the first of his contributions to the article, explains that the hammer stroke perhaps causes heat, which is followed by partial combustion; the remaining oxygen, having been made free from its oxide, forcefully causes the noise:

Der kalte Schlag, indem er den Stoff stark zu sammen drückt, und vielleicht einige Wärme erregt, bewirkt eine unvollkommene Verbrennung (Oxydation) des Phosphors, und folglich eine blos partielle Bindung des Oxygen, wovon der Theil, welcher durch den brennbaren Stoff nicht fixirt wird, das Geräusch hervorbringt, in dem er Elasticität erhält (*17*, 614).

In his second contribution to the article van Mons describes in more detail his notion that the hammer stroke forces the oxygen and heat out of the oxide, and that the rest of the oxide contains enough heat to become elastic:

Je mehr ich die Erfahrungen über die Detonation wiederhohle, desto gewisser scheint mir die Muthmaßung zu werden, daß durch den Schlag oder Druck das Oxygen und der Wärmestoff zugleich aus der oxydirten Substanz gedrückt werden. Die Wirkung ist gewissermaßen mechanisch und der verbrennliche Körper trägt blos durch die Figirung eines Antheils Oxygens zu dieser Erscheinung bey, wodurch der übrige Antheil dieses Grundstoffs die nöthige Menge Wärmestoff erhält, um in den elastischen Zustand überzugehen. Dies scheint um so viel wahrscheinlicher, weil durch die Erhitzung und Entziehung des Sauerstoffs dasselbe bewirkt wird (*17*, 618).

Thomas Hoyle sums up the reactions in his experiments, and, as the others, explains detonation through the sudden release of gases:

Obgleich die vorhergehenden Versuche nicht so angestellt wurden, daß alle Erfolge derselben hätten genauer untersucht werden können, so wird doch folgende auf dieselben gegründete Muthmaßung erlaubt seyn. Wahrscheinlich verbindet sich der Sauerstoff nach Maaßgabe der Heftigkeit der Verbrennung mit dem Phosphor zum phosphorigtsauren Gas oder zur Phosphorsäure; mit dem Schwefel zum schwefligtsauren Gas, oder zur Schwefelsäure; mit der Kohle und andern Pflanzensubstanzen zur Kohlenstoffsäure; vielleicht zersetzt derselbe das Operment in schwefligtsaures Gas und Arseniksäure.

Die Ursache der Detonation beruht höchstwahrscheinlich auf der Elasticität und der Heftigkeit, mit welcher die schnelle Entwickelung der Gasarten auf die umgebende Luft wirkt und sie comprimirt. Die salzigte Säure vereinigt sich sehr wahrscheinlich mit den übrigbleibenden Kali und etwas von dem angewandten oxydirbaren Stoffe; bey Anwendungen der Schwefel- oder Salpetersäure scheint die salzigte Säure in Freyheit gesezt zu werden (*17*, 624).

Of all the contributors Hoyle is the least explanatory. Brugnatelli actually mentions affinity, and van Mons has the most detailed and sophisticated approach since he does attempt to trace the problem of heat through the experiments. But all the contributors show how the pneumatics debate could be extended into areas of physics through the examination of combustion in conjunction with the behaviour of particles under pressure or in expansion.

Although phosphorus was not the analogy for the deflagration experiments, it is, in this article in Scherer, used in two experiments by Brugnatelli and van Mons which stand out from the other experiments using different substances, for descriptive, anecdotal, and hence perhaps even, in the light of Novalis's views on phosphorus, for pedagogic and symbolic purposes. Brugnatelli describes in his first experiment how the use of phosphorus caused the most terrible explosion he had ever experienced. Admittedly, one must add that he was not expecting the phosphorus to cause such dramatic effects, and that he may have been somewhat generous in the amount he was using; but, this, importantly, is part of the novelty of phosphorus in these deflagration experiments:

*Erster Versuch*. Ich nahm ein Quentchen krystallisirtes *salpetersaures Silber*, und legte es auf einen großen Ambos, mitten unter die Krystallen eine sehr dünne Lamelle *Phosphor*: die Temperatur der Atmosphäre während dieser Versuche, stieg nicht über 6° über das Zero des Reaumürschen Thermometers; nachdem alles so eingerichtet war, schlug ich mit einem Hammer ein wenig stark auf die Mischung; worauf eine der fürchterlichsten Detonationen erfolgte, die ich jemals erlebt habe. Der Ambos und sein hölzerner Träger wurden dadurch erschüttert. Man bemerkte auf dem Ambos 5 bis 6 Linien lange Spuren von Silber; einer von den Rändern des Hammers ward zurückgebogen und aufwärts gekehrt; ich war ganz davon betäubt, und meine Kleider waren an verschiedenen Stellen durchlöchert.

Ich wiederholte denselben Versuch zu verschiedenen Malen, und selbst in meinen Vorlesungen, und ob ich gleich nur mit einigen Gran Salz den Versuch anstellte, so war doch der Knall niemals schwächer, als der von einem Flintenschusse (*17*, 605).

In a pedagogic sense, here, phosphorus must have made an impression on the audience, and Novalis could have seen the dramatic symbolic uses of phosphorus, as a strong image for the imagination in his notion of concrete theory.

Van Mons describes how his phosphorus experiments set terror into his audience. Again, Novalis could have seen phosphorus's symbolic use here. Further, as with Brugnatelli, it appears that phosphorus was perhaps at the forefront of the deflagration experimentation that was moving away from the notion that particular substances were explosive to the notion that deflagration should be on the agenda for a general inquiry into matter. For Van Mons expresses sorrow that the novel results obtained with phosphorus could not be tested with sulphur and carbon because he had run out of "salzsaures Ammoniak". This, or "salzsaures Kali" as Brugnatelli calls it, was the substance chemists usually thought of when dealing with deflagration, and it interestingly appears that it was in this context that the unexpected results obtained from phosphorus led them to broaden their inquiry. Van Mons writes:

Ich hatte noch ungefähr 5 Grane *salzsaures Ammoniak*, wovon ich die Hälfte mit ungefähr 4 Gran *Phosphor* anwendete; da ich die beyden Substanzen mit aller Vorsicht zerrieb, um sie zu mischen, so entstand ein so entsezliches Verpuffen, daß das ganze Haus in Schrecken gesezt wurde. Der Phosphor war größtenteils auf meinen Hut geschleudert worden und dieser brannte lange, bevor ich es gewahr wurde. Die Heftigkeit des Schlags hatte mir den Hammer aus den Händen gerissen; ich hatte sehr deutlich bemerkt, daß er von den expandirten Gasarten empor gehoben worden war. Die andere Hälfte des *salzsauren Ammoniaks* wurde ganz allein auf einen umgestürzten eisernen Mörser gethan, und etwas derb mit dem kalten Hammer geschlagen; schon der erste Schlag verursachte ein Verpuffen desselben; allein es wurde kein Licht entbunden. Es that mir leid, daß ich nichts von diesem Salze mehr übrig hatte, um es mit Schwefel und Kohle zu versuchen (*17*, 612-613).

Further suggestion of the novelty of the phosphorus for these deflagration experiments comes out two pages later in the article, where van Mons warns experimenters who are new to this area of inquiry to be cautious, above all with their use of phosphorus:

> Denen, die mit dergleichen Versuchen nicht genau bekannt sind, muß ich anzeigen, daß, wenn man mehr als anderthalb oder höchstens zwey Gran Phosphor nimmt, man Gefahr läuft, sich die Hände oder Kleider zu verbrennen, da die übrigen Stückchen Phosphor brennend umherfliegen (*17*, 614-615).

Such amusing anecdotes are highly instructive when it comes to understanding Novalis. Thus, although phosphorus was only one of the many substances used in the detonation experiments, and although it was not the analogy or symbol for deflagration for these experimenters, it further illuminates Novalis's notion of phosphorus as a "Muster des Experimentirens": both anecdotally and scientifically, phosphorus in the above experiments perhaps "sparked off" the wider notions of deflagration. Furthermore, the very surprising effects of phosphorus, which make it the stuff of anecdote, implant it in the memory, where it can serve a function very close to Novalis's idea of symbolic substances. Interestingly, the experimental context of the lecture hall itself could have suited Novalis's idea of a chemical theatre - as mentioned, perhaps as a modernization of the idea of a memory theatre - where phosphorus could contribute to a form of "phenomenal" calculus in the dramatic aesthetics of scientific productivity. It is important to emphasize, once again, that entails a practical form of social knowledge with a strong epistemological underpinning.

### *3.3. Novalis's own extension of his programme in his ideas on the use of phosphorus for matter theory: cosmological modelling.*

The uses and limits of phosphorus in contemporary science as regards its role in chemistry, where it has with broad physical implications, have been traced in the previous sections. However, Novalis himself entertained experimental uses of phosphorus that went further into physics. His thoughts are contained in a section of the *Freiberger naturwissenschaftliche Studien* entitled *Gravitationslehre* (*N*, 3, 69-72). Here, Novalis puts forward his own model of the universe, and he suggests some experiments designed to illustrate his ideas. In these experiments, phosphorus plays a major role. The notes explain planetary motion in terms of excitability, organization, and affinity. The views stand in direct opposition to the traditional picture of Newton and modern science, by relativising the role of Newton's laws. More fundamental than the inverse square law to Novalis is the heterogeneity of, and are differences in, mass. Novalis is speaking of a dynamic process of gravity in distinction to a mechanical model:

Überall ist *Masse* - nur durch die Ungleichheiten der Masse *entsteht die Schwere* (*N*, 3, 69).

Instead of treating mass in terms of quantity, Novalis suggests that the law of gravity should be based upon the dynamic relationships of all mass.

Updating the organic view of Nature with inventive precision, Novalis compares the planets to muscles. Behind this image stand Renaissance ideas of the earth as a living body with grass as its hair, for instance, and the much more recent cosmology of the Kant-Laplace system. For Novalis, the planets are organized wholes which, excited by affinity, move externally and change internally. Primary to this system of planetary motion is thus not mechanics, but pathology and chemistry. That Novalis does not speak directly of affinity or "Sympathie" in these remarks can be explained by the fact that he uses "Reitz" or "Schwere" as their synonyms; particularly, he is trying to distance himself from the work of Pierre Simon de Laplace (1749-1827), on whom he was here making notes in a highly independent and creative fashion. He takes up Laplace's belief in the universality of affinity for large and small bodies, but attempts to go further by redefining affinity; he expands the common concept rooted in mechanics and chemistry, which Laplace was also using, and, incorporates into it the notion of "Reitz", with all its connotations of organization. Indeed, as mentioned, Novalis even accommodates gravity ("Schwere") to this scheme, using the term in the same sense as "Reitz".[26] He observes:

Elastisch schwere Körper - die pos[itiv] und neg[ativ] Schwer zugleich sind, die eine *Zeitlang* fallen bis zu einem terminus, wo sie wieder steigen - *Muskeln* - und solche Muskeln sind unsre Weltkörper. Der voll[kommene] *Muskel* füllt sich wohl nicht mit Speise um von dem *Maximo* zum Minimo zurückzukehren, oder verwandelt gar seine Gestalt, wie z.B. alle Verkalkbare, Schmelzbare und verdampfbare K[örper], die eben deswegen wohl unvollkomne Muskeln sind (*N*, 3, 69-70).

Novalis envisages planetary motion as a process of relative polarity and as a process of relative combustion or chemical activity. He is viewing matter neither statically nor elementally, but as an organized dynamic whole. The purposiveness of matter itself, not so apparent in laboratory experiments with "Verkalkbare, Schmelzbare und verdampfbare K[örper]", and to many scientists without natural philosophical inclinations not apparent at all, is, for Novalis, readily appreciable when observed on the grand scale of heavenly movement. As this and other fragments indicate, for Novalis, the greater the body, the more scope there is for organization. Consequently, too, Novalis explains gravity as an evolutionary, generative process which forms heavy bodies. Clearly, he takes a bold step here in his remarks, from viewing gravity in terms of traditional mechanics, to a view based upon chemical organization and its primary force, affinity. Although this stance is, in its rudiments, derived from combining Renaissance anthropomorphism with the Kant-Laplace system, Novalis's views, as mentioned, do incorporate a novel extension. For Novalis transforms the mechanist centre of gravity into the chemical burning point of the soul, which resides in the purposive entity of gravity:

Ein Gravitationsprocess erzeugt schwere Körper. Der Brennpunkt ist nichts, als das Leben der Schwere - der Sitz der Schwerseele - die d[as] Gleichgewicht bestimmt (*N*, 3, 69).

Affinity (denoted by "Reitz") is understood as the general force in all bodies, large and small - a common interpretation in the sciences -, but Novalis further emphasizes the purposiveness in matter, and calls this early speculation on energy the "soul" of matter. Furthermore, boldly tackling the fundamental question of the relation between chemical affinity and Newtonian attraction which preoccupied chemists after Newton, Novalis suggests that *all* the affinities of all bodies collect together in the universal phenomenon of gravity, and that they do so in an organized process within a "fluid" state:

Verwandeln sich nicht alle Reitze in diesen Univers[al]Reitz der Schwere, wenn *beyde Körper* in Einem Fluido sind (*N*, 3 , 71).

Novalis's introduction of the term "fluid" gives a decidedly substantial meaning to the Newtonian concept of a celestial ether. He then lends concreteness to his speculation by proposing experiments with substances placed in the "fluids" of water and air. By "fluid", he essentially means a general medium in which bodies move, but the concept for him has strong chemical connotations. Novalis's proposed experiments serve as cosmological models based fundamentally on a chemical view of nature as an organization, and are an attempt specifically to answer the following question he sets:

Würde nicht jeder *gereizte Körper* sich dem Körper der ihn reizte, in einem gewissen Verhältnisse nähern - bis zu einem Puncte, und dann sich wieder entfernen - z.B. bey der Wärme - wenn *beyde K[örper]* im weiten Weltraume *schwömmen*? (*N*, 3, 71).

Novalis is here touching on the origins of celestial attraction and repulsion; his experiments are designed to address this breathtakingly speculative issue in a highly practical way.

He first suggests a cosmological experiment which involves placing combusting balls of substances together in order to observe whether the chemical stimulation ("Reitz") of affinity causes particular movements:

Aller Reitz zieht an - *dehnt aus* - und stößt auch wieder ab. (Physiologie.)
(Statt der cartesischen Teufel - (Glas)kugeln mit Selbstentzündlicher Masse inwendig - z.B. eine Glaskugel und eine Metallkugel beyde mit entzündlicher Masse gemischt - oder PhosphorKugel - und eine von innen sich erhitzende Metallkugel - hier würde die Phosphorkugel um die andre herumtanzen.-) (*N*, 3, 72).

Novalis appears to be setting up his model above all in contrast to that in Descartes's (1596-1650) *Principia Philosophiae*(1644), as much as in opposition to the whole "billiard-ball" model of the universe, commonly believed to be espoused by the Newtonians. The reference to "der cartesischen Teufel" could allude to an apparatus Descartes, or his followers, devised to demonstrate their notions of celestial movement and the behaviour of particles. Or it could perhaps refer to Cartesian models of matter in a more general sense, as theories of matter. It could also even be interpreted as the "devil" Descartes had let loose by his splitting of mind and matter, and his belief solely in matter in the world of Nature. This made it extremely difficult to explain the causes of motion of bodies, or notions of organization at all, for the Cartesian "immaterial" soul was quite simply a different category of existence from matter. French has pointed to a major aspect of this problem:

> ... but on the Continent, so completely had Descartes banished the lower activities of the soul that "soul" was equated with "mind" or consciousness: It cannot be the soul that constructs the body or controls its every action, for we are not conscious of it doing so. Yet again the question arises: If the body is the machine, what moves the parts? (*171*, 125).

Further, there were indeed considerable differences between Cartesian and Newtonian corpuscularity, which Novalis seems to be explicitly stressing in his dismissal of the Cartesian "Teufel". As French remarks, Newtonianism was not so radically mechanical as Cartesianism. For Newtonianism did not entirely reject the notion of organization or a life force in matter itself, and "retained some suggestion of innate mobility and nonparticulate subtlety" (*171*, 113). Thus, in the experiment he proposes, instead of passive, mechanical entities (e.g. Descartes's particles), Novalis elects *combustible* examples to account for "animate", organized matter; and, once again, he chooses phosphorus as a paradigm.

He also develops experiments (such as placing drops of oil on water) which expand the traditional demonstrations associated with affinity by introducing the burning process:

> Ein brennender Oeltropfen neben einem Andern auf dem Wasser - ein sehr heißes *Rohr* im Wasser - um das sich nachher der planetarische Körper herum bewegte. Ein Stück Phosphor laß ich in einer Nußschale voll Wasser schwimmen, oder ein wenig Schwefel und nähere ihm eine glühende Metallspitze (*N*, 3 , 72).

In all these experiments Novalis wishes to observe and connect the phenomena of cohesion, elasticity, chemical affinity, and heat, to observe their effects on the motion of substances. His experiments thus indicate that his notion of planetary motion is one of large-scale organized heat transfer:

Die Bahn der Weltkörper wird durch ihre Elasticität bestimmt - durch die Sfäre ihrer Erregbarkeit (*N*, 3, 71).

Affinity causes both elasticity and heat; on a large scale, this affinity (manifesting as elasticity) determines planetary excitability. Thus Novalis interconnects affinity, elasticity, excitability and planetary motion, harnessing chemical, physiological and pathological ideas to an understanding of celestial motion.

Novalis's interest in camphor also most probably lies in the type of cosmological speculation that he associates with phosphorus. Novalis seems to have singled out camphor specifically for this reason, since camphor does not appear to play a significant role in the pneumatic debate in the areas of combustion or detonation. However, once again, contemporary studies illuminate the importance of the substance. There is in Scherer's *Allgemeines Journal der Chemie* a summary by Fourcroy of Benedict Prevost's work on the effluences of odorous substances (*84*; *5*, 1, 143-166).[27] In his experiments, Prevost studies the movements and effects of substances on one another on a metal sheet covered by a fine surface of water. As Fourcroy states, the most striking effects were achieved with camphor. He draws attention to the neglected results of C.A. von Bergen, who had already experimented with camphor on water in 1754; he then cites a passage from Bergen, which defines the curious property of camphor:

Mit Verwunderung sahe ich aus der Peripherie eines jeden Theilchens viel pinselförmige Ströme einer sehr feinen Materie ausfließen (*84*, 166).[28]

This curious phenomenon is hardly less striking, though it may be less glamorous, than the behaviour of phosphorus. One can see how, for Novalis, camphor would presumably have had similar physical implications as phosphorus did for his own cosmological model. Indeed, among the experiments Fourcroy calls most striking, there are clear parallels to Novalis's suggested experiments with the balls of phosphorus. In Prevost's experiments, camphor and lead are placed opposite each other on a leaf of zinc ("Scheibe"). The leaf of zinc then begins to move in circular fashion. The type of action in the following experiment described by Prevost is closely analogous to that subsequently proposed by Novalis as a model for studying the effect of chemical processes on planetary motion:

Das Ausstromen dieser Flüssigkeit geschieht mit einer Regularität, die im folgenden Versuche frappant wird. Man bringe ein rundes Stückchen Campher von einer Linie im Durchmesser, auf den Rand einer Scheibe von vier Linien, welche in einem nicht sehr hohen cylindrischen Gefäß von 6 bis 7 Zoll im Durchmesser auf dem Wasser schwimmt - gerade gegen über lege man ein Stückchen Bley von derselben Schwere; wenn alles ganz ruhig ist, wird sich die Scheibe kreisförmig um den Cylinder drehen, so daß die Tangente des Umkreises durch den Campher und das Bley gehen wird; anfangs dreht sie sich bis zu 5 Malen in einer Minute (*84*, 161).

Clearly, this description cannot be adduced as a direct source of Novalis's ideas, but in that it is representative of contemporary thinking, it does show how he might have seen camphor as a cosmological model.

However, there were also quite different influences on Novalis's cosmological modelling unconnected to phosphorus and camphor. On the same page where Novalis puts forward his suggestions for cosmological models, he remarks:

Rumfords Versuch - die Wärmeleitung Anschaulich zu machen (*N*, 3, 72).

Novalis is referring to the experiments that Count Rumford (1743-1814) undertook by observing dust particles in heated "Weingeist" (*102*). In his way, Rumford attempted successfully to provide a model for heat at a deep level theory of matter. This, presumably, influenced Novalis's own concrete approach to deep level matter theory through models in laboratory experimentation. Importantly for Novalis, Rumford argues that heat was a motion of particles and not a chemical element that expanded through substances (*215*, 85-86). Rumford concludes his experiments feeling that his observed motion of dust particles was proof enough of this:

Da die Resultate dieser Versuche auf die entscheidenste Art beweisen, daß die Fortpflanzung der Wärme im Wasser, nicht nur durch solche Dinge aufgehalten wird, welche seine Flüssigkeit vermindern, sondern auch durch solche, welche auf mechanische Weise, und ohne eine Verbindung damit einzugehen, die innern Bewegungen hemmen, so scheint es mir, daß dadurch fast bis zur

Demonstration erwiesen wird, daß die Wärme im Wasser nur zu *Folge* der innern Bewegungen desselben fortgepflanzt, - oder, daß sie von den Teilchen dieses Liquidiums transportirt oder *fortgeführt* (carried) wird, und sich nicht, wie man gewöhnlich glaubt, darin ausbreitet und expandirt (*102*, 441).

The view of matter and heat developed here is close to Novalis's own (but naturally Novalis differs from Rumford in his notions of organization). Indeed, after referring to Rumford's model of heat, Novalis speaks of the "immanent" elliptical motions in "fluids": he refers to "fluids" in a chemical sense as in Rumford's experiments with "Weingeist", but also to other possible models of "fluids" which can illuminate electricity, magnetism and light:

Über die Ellyptischen, immanenten Bewegungen von Heterogenëisirten Flüssigkeiten. *(Lateralwirckungen der Ströme.)* El[ektricitaet], Magnet[ismus]. Licht (*N*, 3, 72).

A sense of Novalis's notion of "immanent" elliptical motions can be seen in Rumford's experiments where Rumford rotates the tube containing the "Weingeist", thus altering the current of the dust particles:

Da ich die Bewegung des Weingeistes mit einem Linsenglas näher betrachtete, so fand ich, daß der *aufsteigende* Strom die *Achse* der *Röhre* einnahm; der *heruntergehende* aber *längst* der Wand war. Als ich die Röhre etwas neigte, bewegte sich der *aufsteigende* Strom außer der Achse und gieng längst der obern Wand der Röhre, indeß der *herabsteigende* Strom die ganze untere Seite der Röhre einnahm (*102*, 424).

Novalis remarks after his reference to Rumford's experiment on "fluid" models show his wish to build up some analogy between laboratory models of matter on a small scale with natural forces and the greater planetary movements. Moreover, they reveal to us the very wide "hinterland" of ideas which Novalis channeled into his views.

Contrasting phosphorus with the substances used by Rumford, it further seems likely that Novalis singled out phosphorus because it lent credence to his view that the inorganic world was "alive". Phosphorus supported the view that the whole of nature was a living organism, since it "naturally" (i.e. spontaneously) combusted. Camphor, too, was an exemplary substance since it also quite "naturally" produced chemical and physical effects. Without human intervention phosphorus glowed in the dark: this self-active glowing was paradigmatic of Novalis's view that the universe was driven by affinity, "Lust" and "Unlust" (*N*, 3, 423), fulfilling his belief in the force of "Sympathie". Accordingly, it illustrated his view that the "world soul" was a fundamental physical organizing force, although transcendent, or as Novalis puts it here, transitory:

Überall wird eine *Kraft*, oder *Action* (quod idem est.) transitorisch sichtbar - die durchaus verbreitet, unter *gewissen eintretenden Bedingungen (Berührungen)* sich zu offenbaren, wircksam zu werden scheint. Diese mystische Kraft scheint die Kraft der Lust und Unlust zu sein - deren *begeisternde* Wirckungen wir so ausgezeichnet in den *wollüstigen* Empfindungen zu bemercken glauben.

(Alle Wirckungen sind nichts, als Wirckungen Einer Kraft, der Weltseele - die sich nur unter verschiednen Bedingungen, Verhältnissen und Umständen, offenbart - die überall und nirgends ist ...) (*N*, 3, 423).

Novalis sets forth his view with considerable caution, both emphasizing its hypothetical character (repeatedly using the word "scheinen"), and qualifying it by phrases like "unter gewissen ... Bedingungen". By such means, he integrates his scientific with his religious approach, mediating the two by constant reference to human factors. The human mean constantly recurs, typifying Novalis's pathological-vitalist view of nature. The latter further comes to light in the remarks he makes on the similarities between combustion and nutrition:

Alle Wircksamkeit ist Folge eines Repulsivprocesses - oder des mechanischen Secretions und Gährungsprocesses - Man kann aber auch umgekehrt sagen - der Grund aller Veränderung ist *Freßbegierde* - Combustionstendenz - Nutritionstrieb - durch diesen entsteht erst, als nothwendige Folge, Secretion.

Hauptfrage - Ist das Ernähren des Absonderns oder das Absondern des Ernährens wegen?

Diese Frage führt zur Auflösung - daß beydes Accidenzen sind - deren Action die eigentliche Substanz ist - die Generationsaction (N, 3, 100).

Here, Novalis juxtaposes basic animal drives with combustion. Again, he points out that the initial or final states in combustion (or nutrition) are not the real centre of any matter theory: the real cause of nature's activity lies in the original generative force itself.

Novalis goes so far as to speculate on a natural hierarchy of combustion. This remark reveals the fundamental importance of combustion, flames, and fire in his thought. For he considers fire as a higher realm within the kingdoms of Nature and also as a characteristic of all phenomena; far from envisaging a separate substance like "caloric", *all* chemical activity has a "Flammennatur", since substances react with one another, and hence, analogically, "eat" one another as a flame would "eat" them. The importance of the remark is indicated by its heading, which connects "philosophy" and "experiment":

Philosophische Instruction für den Experimentator.
Sollte die *Flamme*, der Funken, etc. in ein *neues Reich* gehören, das von Pflanzen, Thier, und Menschenreich verschieden wäre. Lebendige Processe.

4 Arten von Flammen - 1. diejenige, deren Excremente - die anorgischen Naturen sind. 2. deren Excremente - Pflanzen - 3. deren Excremente - Thiere. 4. deren Excremente - Menschen sind. Je höher die Flamme - Je *künstlicher* - desto complicirter gebildeter das Excrement.
Alles Fressen ist ein Assimilationsprocess - Verbindungs - Generationsprocess (*N*, 3, 84-85).

Fire appears to occupy the highest point in this view of Nature. It was not without precedent historically to view fire in such a deeper sense. For Heraclitus (circa 500 BC) fire was supreme; and, more recently, Hermann Boerhaave (1668-1738) held it in high esteem (*203*, 15-16; *151*, 24-26). The importance that fire has in this remark, and by extension, in Novalis's thought (see for example, the references already made to Fichte's "Flamme" and Plotinos's light), further helps us to understand his choice of the very combustible phosphorus, as a substance paradigmatic of natural processes.[29]

To conclude, it has now been seen what Novalis's programme for natural philosophical productivity, which aimed at unifying theory, may have looked like. Epistemological aspects, such as key symbols and the method of "phenomenal" calculus, tend to outweigh the social factors in Novalis's programme. This is in accord with Novalis's notion of "experiment", which itself primarily underlines the need to check and reflect upon cognitive gain. Of course the elements of these social aspects of Novalis's thought are significant. They are also of value for reflection on the history of science. However, it has again to be stressed that epistemology is Novalis's prime concern.

This chapter has been concerned with the adequacy of Novalis's programme of natural philosophical productivity for unifying theory: Novalis had made the beginnings of such an undertaking, but, naturally, given the demands and nature of such a project, it remains at the level of a possibility. Yet perhaps the most important part of the project, his idea of "phenomenal" calculus, was sufficiently developed and illustrated by Novalis himself. However, this still leaves the symbols of his system wanting. Even though a wealth of support for Novalis's programme for unifying theory arises out of his treatment of phosphorus, this is still only one key substance, found in only one, albeit significant, fragment. None the less, the contextualization of phosphorus, in the sciences of the time and in Novalis's thought itself, has shown ample evidence for this side of Novalis's programme for productivity, and has therefore given an indication of the direction of Novalis's thoughts on this topic.

The next chapter will illustrate how Novalis's later thought moves away from such a large endeavour to find respite and, most probably consensus, in natural philosophical productivity for the individual inquirer. This programme for natural philosophical productivity is concerned with the unification of practice through a consensuality based upon the realization of the individual's methodology and his interdisciplinary theory.

*4. Excursus: aspects of alchemical texts on one of Novalis's book lists and their significance for his idea of science.*

This excursus only wishes to illustrate some aspects of alchemical texts in one of Novalis's book lists and to relate them to his stance to the sciences of his time. Clearly, no work on Novalis's ideas on chemistry should fail to take account of alchemy. While it is true that Novalis's views on chemistry have to be seen in the light of eighteenth-century chemistry and natural philosophy, there are also considerable methodological issues and notions of matter theory which arise out of alchemy. On the book list mentioned by Novalis early on in the *Freiberger naturwissenschaftliche Studien*[30] one of the texts, Georg Wolffgang Wedel's *Einleitung zur Alchemie* (1724), is of particular relevance (*123*). This is a text that sets out to provide the apprentice alchemist with an insight into the tradition, aims, method and pitfalls of alchemy. Wedel openly discusses several major questions: notably the fundamental outlook of the alchemists, and their Neoplatonic, Hermetic and Cabalist way of thinking. The importance of Hermes Trismegistus, the notion of the chemical marriage, and also the general mystical notion of "Sympathie", so important to Novalis, are readily apparent in Wedel's work. Thus Wedel's introduction to the subject provides a useful key to the interests of alchemists which are so often obfuscated in the other texts on Novalis's book list. The value of the text in relation to Novalis's science lies, not least, in the fact that Wedel appears to adapt alchemy to a more modern scientific perspective.

It has been established that major sources of Neoplatonic thought for Novalis were Hemsterhuis and Plotinos. However, Wedel's work is naturally symptomatic of this tradition too, and gains added interest for its "scientific" content, which provides an invaluable backdrop to Novalis's thought. Wedel's book both illuminates Novalis's thoughts on alchemy, and throws light on how Novalis reinterpreted the Neoplatonic agenda for the sciences of his time.

Wedel's views show just how much alchemists were concerned with experience and their experimental procedures, however much their works are couched in the metaphysical:

Es ist ein ganz gemeines Axioma: Ein einzig Experiment mehr werth, als hundert rationes; Also gilt dasselbe auch billig von der *Alchemie*; Und solches um so viel mehr, je leichter der Verstand damit überein stimmet, wann er durch die *Raisons* dazu verleitet wird, daß dieselben nicht darwider sind, sondern der Experienz nachgeben und sich unterwerffen (*123*, 19) ... Sondern er [*the alchemist*] soll indifferent seyn, der so viel auf *Theoriam* hält, als auff *Praxin*, auch diese ohne jene nicht anfangen, dergleichen nicht aberglaublich, wie solches viele mit Schaden erfahren (*123*, 35).

In a similar manner, concerning alchemical practice itself, Wedel suggests that the alchemist should work carefully, and concentrate on the "Particularen" and not on the "Universalen" (*123*, 92). Those who jump immediately to the "universals" are obsessed by equating some substance with the "Tinctur" or stone itself. He remarks that some overhastily deem it simpler to claim that they have found the stone itself than to spend hard work studying the "particulars" ("den *Lapidem* selbst zu machen, als ein *Particulare*" (*123*, 92)).

Moreover, Novalis's "Glaube" or "Kindlichkeit" (*N*, 3, 179), the fundament required for his notion of "Plotins Physik", can be understood as a direct parallel to the alchemical belief in magical signs and figures, since both of these attitudes in fact argue for a great intimacy with Nature. To Wedel, a better understanding of natural processes is afforded through concrete signs and symbols:

Dieses [*the alchemist's use of symbols and hieroglyphics*] gilt auch von den Figuren, womit sie offt besser, als durch den Text selbst, die Wissenschaft der Ingredientien und des Processus haben zu verstehen geben wollen (123, 43).

The closeness of Wedel's practical alchemical procedure and the use of symbols to Novalis's notion of an *a priori* "Physik" can readily be seen: both Wedel, as natural for an alchemist, and Novalis envisage a concrete approach to theorizing that employs symbols of things in an inner language of the mind. In a similar manner Cabalist number permutations are forms of concrete theorizing: for example, the work of Jabir Ibn Hayyan (720-813) is an early attempt at actually ordering substances through the use of a magic square of numbers (*201*, 75-78). The alchemical use of symbols is also naturally a precursor to affinity tables and chemical formulae.[31] Modifying the alchemical use of symbolism with, for example, a stance such as is evinced by Wedel, one arrives at a base for such eighteenth-century products as the affinity tables; in such conceptual tools, a concrete methodology survives, as do the alchemists's visual symbols, but the understanding of the chemical substances is enhanced by modern knowledge.

Novalis seems highly aware of just such a continuity (from alchemical inquiry) into the "Physik" of his time. He remarks:

Die Physik der Alten und des Mittelalters ist äußerst *merckwürdig* - bes[onders] als Versuche a priori zu *physiciren. Junge* Physik der Alten - Antike Physik der Modernen (*N*, 3, 86).

Novalis may here refer to the concrete *a priori* of pre-Socratic philosophy and Aristotelian physics, as well as to the various aspects of medieval cosmology and alchemical inquiry. Furthermore, his remark implies the hope for a reconciliation of these supposedly superseded methodological attitudes with those of his contemporary sciences. He felt, as has already been examined in his Socratic programme, that concrete debate, compelling participators to use "innate" knowledge and symbols, would keep the sciences alive and bring about great advancements. Importantly Novalis's Socratic programme, although, like alchemy, a concrete procedure, paves a way beyond the secrecy and elitism of alchemy to the modern lecture hall and the possibilities of open debate and inquiry in the "market" of science.

The idea that the ancient and the modern chemistry could somehow be reconciled within the realm of open debate was indeed a source of great concern to Novalis. Thus, for instance, he suggests how the modern French chemistry, although now, unlike alchemy, public, was dogmatic. In criticizing the new French chemistry, he asserts that the French had turned oxygen - which had such a pivotal role in the new science - into a new philosopher's stone of inquiry:

Die Antiphlogistiker machen das Oxigène zum Stein d[er] Weisen (*N*, 3, 317).

The provocative form of his remark itself stimulates openness. It may also recall the open method of alchemy. For as Novalis remarks elsewhere, the stone was always an ideal or aim: the unattainability of this goal guaranteed openness. The stone was not a materialist "concrete" fetish, like oxygen:

Es giebt keine Phil[osophie] in Concreto. Phil[osophie] ist, wie der Stein d[er] Weisen ... eine bloße nothw[endige] Aufgabe der Szientifiker - das *Ideal der Wissensch[aft]* überhaupt (*N*, 3, 385).

Indeed, Novalis thought of the stone in its most profound sense, as a natural force, as part of the purposive whole of Nature. He equates the stone with the conscious continuum of Nature. As such, it is comparable to the "Genie" of man, and, is itself, in his view, the organized ether of matter:

Sollte es nicht ein *Vermögen* in uns geben, was dieselbe Rolle hier spielte, wie die *Veste* außer uns - der *Aether* - jene unsichtbar sichtbare Materie, der Stein der Weisen - der überall, und nirgends, alles und nichts ist - *Instinkt* oder Genie heißen wir sie - Sie ist überall *vorher*. Sie ist die *Fülle der Zukunft* - die *Zeitenfülle* überhaupt - in der Zeit, was der Stein der Weisen im Raum ist ... (*N*, 3, 462).

Clearly, the "Stein der Weisen" is one of those several symbolic images around which Novalis's key ideas crystallize, each one seeming to contain the whole of his thought, yet only deriving its full power through contact with the others. Among the several facets of the stone which become apparent here, the one I wish to emphasize now is its spatial futuricity, which ensures (like human "Genie") an open inventiveness of inquiry. To Novalis, the antiphlogistic concept of oxygen was opposed to the "stone", being an example of a debated substance, in the discussion of which theory had taken over, and which now hindered any further debate. The new French chemistry was, from Novalis's point of view, in every sense a closed system, which allowed no reevaluation of first principles. On the contrary, its fixation on oxygen made it backward looking ("Antike Physik"). Novalis's interpretation of the use of phosphorus, on the other hand, was intended to look forward to new theory and discovery. The important point for Novalis, however, is that all areas of inquiry need some ideal in the future; as he figuratively puts it, they should all search for the "stone". This ideal must remain a goal, and should not be allowed to become dogma or formal theory. Moreover, as Novalis's paradoxical formulations in the preceding quotation imply, and in the Plotinian sense, the ideal goal is not conceivable for man. Hence, it cannot be found "in Concreto".

Wedel's final reference to Hermes Trismegistus as the example and source of all alchemical wisdom also raises the whole issue of open inquiry, and, importantly, Novalis's idea of the scientist. Wedel recounts the well-known formula that Hermes was master of three things (*123*, 99). As Frances Yates observes, the Hermetic tradition is of fundamental importance for Renaissance science, and led to "the best-known manual of Renaissance magic" (*300*, 262), Agrippa's (1486-1535) *De occulta philosophia* (*4*), where the triadic idea reccurs. For Yates, Agrippa's book epitomizes the Renaissance:

> The Renaissance ideal of the magus, the "divine" man with powers of operating on the cosmos and achieving universal knowledge and power - adumbrated in Pico's famous *Oration on the Dignity of Man* - found its theorist in Agrippa ... (*300*, 262; *82*).

Agrippa imbibed Marsilio Ficino and Pico della Mirandola, who both (in Renaissance fashion) held the Egyptian Hermes Trismegistus in reverence (*300*, 229; *299*, 150-151). It is Agrippa who gives a paradigm for the Hermetic magus, as master of three spheres: "the elemental world, the celestial world, and the supercelestial world" (*300*, 266). Indeed, Novalis reverts explicitly to the Renaissance ideal of the magus on several occasions, and adapts the figure to his age and into his own thought. He uses the idea of the magus both to support his ideal of the scientist and his own method of knowledge.

In an important fragment, Novalis rehearses the Renaissance ideal of the magus, but implants it into his own notion of the "moral" inquirer. The source here of Novalis's notions is, of course, Hemsterhuis, and Novalis is drawing on the Neoplatonic idea of "Sympathie". It is man's "moral" sense, his ability to perceive the "wunderbare Sympathie" in Nature, and his ability to act accordingly, that explains to Novalis man's potential and his place within the cosmos:

> Wir müssen Magier zu werden suchen, um recht moralisch seyn zu können. Je moralischer, desto harmonischer *mit Gott* - desto göttlicher - desto *verbündeter* mit Gott. Nur durch den Moralischen Sinn wird uns Gott vernehmlich - der moralische Sinn ist der Sinn für *Daseyn*, ohne *äußre Affection* - der Sinn für *Bund* - der Sinn für das Höchste - der Sinn für *Harmonie* - der Sinn für freygewähltes, und erfundenes und dennoch *gemeinschaftliches Leben* - und Seyn - der Sinn fürs Ding an sich - der ächte *Divinationssinn*./ diviniren, etwas ohne Veranlassung, Berührung, vernehmen./ ... (*N*, 3, 250).

Man's "moral sense", as understood by Hemsterhuis, provides the basis for the universal "Sympathie", on which Novalis grounds his notion of knowledge, the "Combinatorik" or calculus of an inner logic of the imagination. Through "Sympathie", the individual magus relates to the divine, opening up the cosmos to man. It is through "Sympathie" that Novalis's inquirer senses objects using a language of the imagination, and not by employing the strict empirical senses ("diviniren, etwas ohne ... Berührung ... vernehmen").

Significantly enough, Novalis spoke in this way of Werner, one of the people whom he most respected, when he refers to the latter's "divinatorischen Sinn" (*N*, 4, 299): Werner, to Novalis, espoused a type of "magical" empiricism. Werner was, for Novalis, a modern magus, who because of his capability to "divine" was a universal scientist, in contact with the whole of Nature; he was a very similar figure, indeed, to the teacher in *Die Lehrlinge zu Saïs*. As already discussed, one of Werner's characteristics was his remarkable sense for natural phenomena. A further remark in the *Das allgemeine Brouillon* explains again how Novalis thought the modern magus should be, and why he refers to a figure such as Werner in terms of a "Divinationssinn":

Der physische Magus weiß die Natur zu beleben, und willkührlich, wie *seinen Leib*, zu behandeln (*N*, 3, 297).

For Novalis the magus can bring Nature to life through "experimentation", both literally in the laboratory, where Nature's secrets are revealed and her language and expression are brought forth. Significantly, too, the teacher in *Die Lehrlinge zu Saïs* brings Nature to life, that is, he reveals her innermost secrets and laws, by taking the overtly non-conceptual step of placing the stone amongst the other stones, and thereby, in a process of directly theorizing with phenomena, creates the pattern, or "Figur" of Nature's inner language. Indeed the key word "Figur" recalls the verb "figiren", which is an alchemical (and chemical) term. For the alchemist, substances, in experimentation, take form and are "figirt" (see, for example, Wedel (*123*, 40)):

Der Lehrer ... legte dieses Steinchen auf einen leeren Platz, der mitten unter andern Steinen lag, gerade wo wie Strahlen viele Reihen sich berührten (*N*, 1, 81).

The teacher's concrete method of explaining Nature is a paradigm for Novalis's "Experimentalphilosophie", just as is "Diogenes Gehn". One may also recall the lines in *Die Lehrlinge zu Saïs* where the child "plasticizes" Nature:

In große bunte Bilder drängten sich die Wahrnehmungen seiner Sinne: er hörte, sah tastete und dachte zugleich (*N*, 1, 80).

Bringing Nature to life, for Novalis, is the fundamental act of explaining her, using her own language, or when man acts as part of Nature, employing concrete images operating on "Sympathie". Novalis's notion of "Magischer Idealism" (*N*, 3, 385) is also this use of concrete notation, the "magic" lying in the marvellous "Sympathie" upon which ideas and images operate. For Novalis refers to his "Magischer Idealism" when speaking of a "Höhere Physik, oder höhere Mathematik" (*N*, 3, 385), and of the latter he maintained:

Der innige Zusammenhang, die Sympathie des Weltalls, ist ihre Basis (*N*, 3, 593).

Further, it is because of Novalis's pathological view of knowledge that the modern magus is able to treat Nature like his body ("willkührlich, wie *seinen Leib*"). Concrete images imply the use of forms of knowing such as "Plastisirung", "Gefühl" and "Reflection". As the above remark on "Divinationssinn" shows, it is primarily the "Sinn" for the "Sympathie" in Nature that gives the magus his special status. That he once named his notion of inquiry "Plotins Physik" is highly appropriate, given the role "Sympathie" plays in Plotinos's thought.

Moreover, in the alchemical texts on Novalis's book list there are indeed passages referring to the creative alchemist, a figure closely akin to the magus. One of the contributors to *Quadratum alchymisticum*, Thoma de Vagan, describes the external creative chaos of the universe and draws the common analogy with the creativeness of the alchemist's art and laboratory. Here, the notion of generation, or of giving birth to knowledge, so vital to Novalis, is also apparent:

Der Himmel aber ist die einige Renn=Bahn aller Sterne/ und großen Lichter/ welche mit ihren Einflüssen sich mit denen Dingen/ so entweder umb/ oder um der Erden ihr Lager haben/ vermischet/ und vereinigt. Allein/ als noch der Himmel und die Erde miteinander vermenget waren/ konnten sie vor nichts anderes als ein CHAOS, gehalten werden/ welches unsere Kunst gar artig/ und verblümet vorstellen kann. Denn unser *Chaos* ist gleichsam eine mineralische Erde/ in Ansehung ihrer *Coagulation*, aber auch eine flüchtige Luft/ in welcher der ganze *Philosophische* Himmel stecket/ der aus einem selbst=eigenen Mittel=punkt lauter Sterne gebähret/ die mit ihrem Lichter die Fläche der ganzen Erde durchscheinen (*87*, Tract 4, 12).

Vagan directly compares the fecundity of the heavens with the alchemist's work. It is suggested that the alchemist too can give birth to "lauter Sterne" in the "flüchtige Luft" of his apparatus.

In a similar spirit to Vagan, Wedel too refers to the alchemist's instrument and apparatus, the "philosophical egg", and its status as a vessel for nurturing matter, and here once more the creational work of the alchemist is brought to light:

Ins gemein wird es ein *Philosophisches Ey* genannt, welches aber ebenfalls von doppelter Bedeutung ist. Denn es bemercket nicht allein eine Aehnlichkeit der Ausbrütung, daß die Materie, als eine *continuirliche* Frucht, *digeriret* werden, und bis ans Ende währen soll, sondern auch ein äusserlich Gefäß (*123*, 78).

Chapter four

# Unifying practice

The probability of individual philosophical productivity as a programme for treating the sciences in terms of practical knowledge.

### *1. Introduction. Ritter's* Beweis *as a type of case study. Fact and "Calcül". Unifying practice as a probable programme for natural philosophical productivity.*

The discussion aboutthe possibility of consensus in Novalis's thought is now to be taken a step further to reveal an area where in all probability Novalis did find his notion of inquiry realized. Consensus is arguably attained at a more encompassing level than that discussed in the previous chapter. As will be seen, in this aspect of Novalis's thought one finds a higher level of consensuality expressed in the practical nature of the interdisciplinary findings of the individual and in the individual's own particular use of the subject in "phenomenal" calculus. A little groundwork is called for now to introduce properly Novalis's notion of a programme of individual philosophical productivity.

In this notion of a programme for the sciences proposed by Novalis, the urge for unity in knowledge is fulfilled in the highest sense in the work of an individual. Indeed, in Ritter's work on galvanism, Novalis found just such an expression of his interdisciplinary ideal of knowledge. This argues, I would like to maintain, for a shift in Novalis's thought from the notion of a project, such as espoused in his encyclopaedism or in his idea of a "symbolische Physik", which approaches the sciences more "externally" through classification, to a project which seeks to tackle the sciences "internally", but in an equally interdisciplinary fashion. This is a shift in Novalis's thought from unifying theory - as seen in Novalis's attempts to classify the sciences - to the unifying of practice in the realization of the individual's methodology and the type of theory based upon the practical knowledge of an interdisciplinary approach to inquiry. The sciences are treated internally through the concentration of inquiry on the processes revolving around a particular case. Ritter's particular case is the phenomenon of galvanism (implied, too, is the nerve), and, as will be seen, in a highly interdisciplinary manner, Ritter harnesses many areas of knowledge and science in order to investigate this phenomenon. Particularly pronounced in this internal interdisciplinary project for the sciences is the role of the individual inquirer and the notion that theoretical attainment is tightly linked to the subject. In this project, the inquirer is creating his own science and attempts to pull existing theory together in a new form. The onus thus lies primarily on the individual inquirer to bring expression to theory. Consequently, the individual's methodology attains prime importance: in this form of natural philosophical productivity, theory is highly dependent on the manner in which the subjective individual interacts with the phenomena under investigation. Thus, in Ritter's work, we find an example of the special significance of Novalis's encompassing notion of "phenomenal" calculus for the inquirer. It is the aesthetics and practical knowledge of the individual which plays so major a role in the attainment of theory in this particular natural philosophical project. That is not to say that this form of inquiry is without social implications, rather the point is heavily stressed that the subject, in Novalis's view, always plays a key role in inquiry. Importantly, the social implications lie in the significance of the individual's methodology and findings. Ritter's work is a paradigm for the notion of individual interdisciplinary inquiry which, when applied to scientific endeavour as a whole, implies that scientists should carry out their investigations according to such principles of individual natural philosophical productivity. This programme for the sciences is different to Novalis's notion of a more socially and lower level consensually oriented programme of a "symbolische Physik", discussed in the previous chapter. For there Novalis is concerned with first finding the principles required for consensuality in the sciences. That is a phenomenal calculus which is concerned more with the programme of the classification and ordering of the sciences. Of course, in a further step consensual principles are then to be used in inquiry in an "Experimentencalcul", but this is a lesser level of consensuality than found in Novalis's programme for individual philosophical productivity. In the latter progamme the emphasis lies on the fact that the individual inquirer works on something akin to a case study, which is itself an interdisciplinary activity. This also places particular emphasis on the way the individual arrives at theory. The type of practical interdisciplinary theory obtained and the realization of the individual's methodology are then upheld as a paradigms of inquiry. In other words, the boundaries between scientific discovery and natural philosophical theorizing are drawn far closer together.

In this programme, Novalis's "phenomenal" calculus employs the notation of a key symbol, just as in his programme for the classification of the sciences, which applies such symbols to inquiry. However, in Novalis's programme for individual natural philosophical productivity, there is arguably an emphasis on the symbol as a "fact". This is a "fact" attained and developed through the individual inquirer's practical knowledge. The term fact (see section 9 below) points to the epistemological tightness and coherence of the individual's natural philosophical productivity as a type of case study.

In a sense, individual natural philosophical productivity can be seen as the individual's realization of Novalis's encyclopaedic programme. Instead of a classification of the sciences, one finds the unifying of theoretical stances in the issues involved in, and crystallizing around, a type of inquiry akin to a case study. For Novalis, the realization of individual methodology in Ritter's diagrams of his experiments and the practical knowledge of his interdisciplinary theory are paradigms of inquiry. This is, arguably, a more encompassing notion of consensuality than that of a metaphor, or, at least, gives expression to the tacit elements of consensuality already found in the idea that consensuality involves the use of metaphors and models. One can say that just such an encompassing notion of consensuality is manifest in Ritter's diagrams and theoretical findings, Humboldt's geognostic pasigraphic diagrams and its related theory, in Werner's geognostical principles, in Goethe's "Urpflanze" and in Schelling's natural philosophical principles such as "Polarität". In all these cases one can see expression of a higher level of consensuality found in the realizations of the individual's methodology and in the practical knowledge of his interdisciplinary theoretical findings. In all the cases concrete, experiential forms of knowledge (such as the visualization of theory, ideal types, natural philosophical principles - all types of aesthetic productivity) are intimately bound up with theory based on interdisciplinary practical knowledge, and offer a powerful type of consensual communication for the sciences.

One can further comment that Novalis's idea of a programmatic individual natural philosophical productivity demands self-reflexivity on the part of the individual and the sciences themselves. Both individual knowledge and scientific theory are put to experiment in this process of self-reflexivity: ultimately, individual knowledge and scientific theory aim to merge into a unity in Novalis's programme for individual natural philosophical productivity. Thus, in this sense of social knowledge Novalis, through this encompassing notion of consensuality, is proposing that the sciences call their methodologies and theory into question, by viewing both as forms of practical knowledge. In this manner Novalis proposes a programme for unifying practice as a whole.

When J.W.Ritter published his *Beweis, daß ein beständiger Galvanismus den Lebensproceß in dem Thierreich begleite* (*R*) in 1798, a major step was made not just for galvanic theory but for Romantic science itself. The implications for natural philosophy in the *Beweis* were far reaching: it appeared that Ritter had "proven" a force in Nature that was akin at an empirical level to Schelling's notion of a "Weltseele". Through his notion of a "constant galvanic force", Ritter believed that he had demonstrated the empirical grounding for purposiveness in natural phenomena. His notion of constant galvanic force held for both the organic and inorganic realms, and this implied that the concepts of "organization" and "organicism" applied to the whole of Nature, and not only to organization within organisms proper.

Indeed, Ritter's notion of galvanism as a general organizing force tends to be overlooked by historians of science, such as Schimank (*272*), Hüffmeier-von Hagen (*202*), Hermann (*194*), Gower (*180*), Berg (*142*) and Richter (*261*), who tend to see Ritter purely in the light of electrochemistry or stimulation physiology, and do not attempt to understand Ritter in the terms of the thought of his own time. Berg and Richter do see Ritter as the founder of bioelectrochemistry, but neglect Ritter's concept of organization. They do however provide important perspectives on the value of Ritter's work as a precursor of aspects of stimulation physiology.[1] Hermann is more thorough in dealing with electrochemistry and its history, and in having a more complex view of developments in chemistry, and a deeper perspective, does more justice to Ritter's view of the inorganic than do Berg or Richter. Clarke also overlooks the notion of organization and falls back upon the unsatisfactory and unexplanatory view of German natural philosophy as a search for unity in Nature, and asserts that Ritter's galvanic interests amount to no more than this (*153*, 178). Gower deals much with "dynamism" in matter theory. He sees Ritter in the light of Kant's and Schelling's dynamism (*180*, 330-331), but does not touch upon the notion of organization. Gower does however, in distinction to all the other historians, comment on the significance of Ritter's work for deep level matter theory, and his pioneering notion of a "constant galvanic force". Importantly, Gower remarks:

It is possible to discern in Ritter's theories, especially those concerned with galvanism and with his explanation of why galvanic action, unlike electrical, magnetic or chemical action, is continuous, a way of using scientific concepts which was novel. In his account of galvanic action, he explicitly claims that there is a continuous conversion of one kind of process into another kind of process. With the benefit of hindsight this could be made clearer by interpreting it as meaning that galvanic action involves what would be now described as energy transference (*180*, 337-338).

Gower adds too:

Of greater significance, perhaps, is the fact that Ritter used the concepts of force and process in some of the same kinds of ways in which the concept of energy later came to be used. For example, the forces and processes to which he refers in his accounts of galvanism are not specific physical forces or processes such as electrical forces or chemical processes (180, 338).

Gower continues by observing that the relationship between, on the one hand, Ritter's notion of fundamental force processes, as implied in a concept such as the "constant galvanic force", and, "on the other hand the specific magnetic, galvanic, chemical processes, is analogous to the relation between the energy concept which appears in, say, the energy conservation principle, and the specific forms of energy, electrical, chemical, etc." (*180*, 338).

The important aspects of Ritter's thought for a deeper level of matter theory are discussed in detail below (see section 4), and, in distinction to Gower, the usefulness of the notion of organization for matter theory will become apparent. Finally, a cultural historian such as Wetzels, who, of all the historians, has covered the natural philosophical aspects of Ritter's thought in the most depth, does none the less not quite do full justice to Ritter's strategy in the *Beweis* (see below, p.310).

For Novalis, however, Ritter's *Beweis* was also a landmark of method in inquiry, and none of the historians of Ritter have dealt with this aspect of Ritter's work. Ritter is commonly enough thought of as cumbersome and inadequate in the expression of his ideas.[2] Although his literary style is not always lucid in its expression, his experimental methodology undoubtedly is. In particular, Novalis saw Ritter's experimental procedure as an archetype of his own methodology. The young Ritter's empirical and inductive leanings, his caution and his strict reliance on the phenomena under investigation had much in common with Novalis's view of experiential knowledge and his progressive, but piecemeal-oriented notion of inquiry. Indeed, Ritter's *Beweis* gave more substance to Novalis's view that "experiment" had to be reevaluated, and taken account of in scientific method. Both Ritter's practice and Novalis's theory stressed the use of laboratory experimentation and the need to remain close to the phenomena under investigation, but also included the need to account for an "experimental", cognitive approach to theorizing in direct relation to phenomena. Thus, Ritter's galvanic theory and practice sought to account for the role of man's 'experimental' perception in the attainment of knowledge. To Novalis, the *Beweis* was an example of how man held the key to the understanding of Nature within himself. Ritter's method and findings provided solid evidence that concrete forms of knowing, as espoused in Novalis's notion of "Plastisiren" (*N*, 3, 123), were themselves fundaments of scientific inquiry. Furthermore, Ritter's *Beweis* also presented Novalis with an empirical picture of his belief in a purposive whole of Nature. Nature was a great organized entity, or "thätig" as both Ritter and Novalis express it. Both Ritter and Novalis view Nature essentially as a Chain of Being, and galvanism gives this notion a thoroughly novel physical grounding; as Ritter inspiredly interprets it, the vast galvanic circuit of Nature was a Chain of Being, "Das organische All":

Fürwahr! ich begreif's nicht; es ist unmöglich, daß sie [ = *die galvanische Kraft*] nicht überall statt finde in der *ganzen Natur*! Wo ist eine Sonne, wo ist ein Atom, die nicht Theil wäre, der nicht gehörte zu diesem *Organischem ALL, lebend in keiner Zeit, jede Zeit fassend in sich?* (*R*, 171).

Ritter conceives of the entire universe as a single organic entity, united by galvanism. This wonderfully enthusiastic exclamation, however, rests on detailed experimentation and profound reflection.

At the biographical level there are significant links between Novalis and Ritter. Novalis visited Ritter in Jena first in Summer 1799, after the publication of the *Beweis* in 1798, and then often in that year: Novalis was thus able to attain a first hand impression of Ritter's laboratory life (*358*, 86). They were both young men, Novalis twenty-seven, Ritter twenty-two, and must have had many thoughts to share. Ritter was particularly affectionate towards Novalis, obviously not only because he freely gave Ritter financial assistance, but primarily because their friendship developed naturally and was genuine. Novalis was "von allen Seiten Stütze und Bestätigung" (*99*, 14-16; *261*, 33; *358*, 87). Novalis's friendship with Ritter also drew the attention of the other Jena Romantics and Ritter was pulled into their circle by Novalis (*358*, 89; *99*, 15). Novalis's death in 1801 was a severe blow for the young physicist, as can be seen in the following lines of a poem of by Ritter:

Freunde schien mir der Himmel zu geben,
Einen gab er endlich mir;
Aber kaum, daß er ihn mir gegeben,
Nahm er wieder ihn hinweg von mir.
Traurig Loos! wenn alles nur beginnet,
Daß es fast beginnend noch zerrinnet.
...
Seinem Geist allein war ich verbunden,
In der Kunst hab ich ihn wiedergefunden (*99*, 30-31).

It seems that their interests were very much the same, even before their meeting, and that their friendship probably developed their common concerns. Ritter's fragments were most probably influenced by conversations with Novalis and by his reading of Novalis's fragments (*261*, 32-33). Moreover, after Novalis's death, Ritter was given Novalis's philosophical and scientific papers by Karl von Hardenberg (*214*, 46-49). There is good cause to suppose that Novalis's ideas influenced Ritter, and that, equally, in their close relationship, they influenced one another, exchanged ideas, and reinforced one another's views. The exact nature of their relationship clearly has to be considered in a study and comparison of their aphorisms: one may assume, given their close friendship and mutual understanding, that Novalis also had some role to play in the development of Ritter's science. This present work seeks to study the reception of Ritter's ideas in Novalis's writings and Ritter's scientific method. This study will show fundamental points of agreement in their views on experimentation, but it is not the aim of this study to explore Novalis's specific role for Ritter's work. I wish only to show points of affinity, and from these significant areas of mutual understanding this work hopes to provide the basis for an examination of Novalis's role for Ritter's scientific work. Such an examination would above all entail, as mentioned, the analysis of Novalis's and Ritter's fragments.

*2. Galvanism in 1798.*

To address galvanism in 1798 and to formulate a fair understanding of the various proponents' views one has to take a broad look down the eighteenth century. Observing Ritter's case in 1798, one can note a fundamental unity between his physical (i.e. electrical and chemical) interests and physiological concerns (i.e. the nerve action). However, this sort of parallelism is not met earlier in the century. The great and influential physiologist Albrecht von Haller (1708-1777) made a clear distinction between electricity and his own particular notion of a nerve fluid: he believed there was not enough evidence to equate the two (*153*, 161-2). However, what does link Ritter back into the context of the earlier eighteenth century is his belief that galvanism was the life force itself, although the life force was not always taken in his sense of "general organization". Haller's physiological nerve force, the "vis nervosa", is also a principle of life. Electricity was also seen as the vital source of life in the eighteenth century (*265*, 28-35). Thus, a life force was commonly believed in, but in general it was not a force that linked physics to physiology. It was, first, Galvani's (1737-1798) experiments in 1791 and his work *De veribus electricitatis in motu musculari. Commentarius* (*35*) which united the fields of physics and physiology, for Galvani put forward the notion that the nerve fluid was an electrical fluid. His findings are important not just because he discovered animal electricity, and in doing so argued against the strong views of those such as the Hallerians and Alexander Munro *secundus* (*153*, *162*), but also for the reason that he reawakened interest in electricity in general. The study of electricity had, since the mid-eighteenth century, undergone a relatively inactive period (*153*, 169). However, Galvani's findings, although influential, were hypothetical: he had taken the common view of a nerve fluid, based upon the ancient Greek idea of the nerve spirits and upon the widespread eighteenth century notion that the brain secreted a fluid, and had interpreted it as an electrical fluid (*153*, 168).

At this point, Volta (1745-1827) turned his attention to the field of galvanism. His greater skills overtook Galvani. Galvanism was not now associated with "physiological electricity" (in the sense of animal electricity) but instead with "physical electricity" in Volta's notion of contact electricity. In 1793 Volta argued purely for the notion of "metallic" electricity. He experimented with a whole frog joined to a bimetallic circuit to show that contractions arose from the contact of dissimilar metals. He further discounted Galvani's success in bringing about contractions through the joining of the crural nerve to the muscle by a single metal. Instead Volta maintained that this experiment of Galvani's for the "proof" of an animal electricity could only be explained in terms of his own "metallic" electricity. He thus claimed that the contractions Galvani brought about by joining the nerve to the muscle with a single piece of metal were caused not by any physiological factors, but by the "contact" between the piece of metal and unobserved impurities in the piece of metal itself (*191*, 492).

However, in 1794 when Galvani published an account of his new and fundamental experiment which proved that contraction could take place without metals (*36*), Volta had to alter his stance. Volta still essentially saw the organic side of the galvanic circuit as entirely passive: to him it was made up merely of conductors of the contact electricity produced by the touch of the two dissimilar metals. But to cater for Galvani's new findings, Volta claimed that the organic part of the galvanic circuit was analogous to, but none the less different from the metal conductors: the muscle and nerve were in his eyes "dissimilar" conductors (*194*, 42-43; *153*, 172; *191*, 493). Volta then moved on to see both solid and fluid conductors as necessary to form the heterogeneity of an active galvanic circuit. Volta's law of heterogeneity states that three heterogeneous conductors are required to make up an active circuit, and with this law he retreats from disregarding the physiological aspects of galvanism (*121*, 127). None the less, Volta clearly still supports the notion of a general physical electricity, and not an inherent animal electricity.

In his *Beweis* of 1798, following up his laboratory work of 1797, Ritter made a decisive jump forward in the field of galvanic theory. Instead of postulating a hypothetical nerve fluid and a form of electricity inherent only in animals, and, also, instead of viewing electricity hypothetically as a fluid in the manner of Volta's notion of electricity (as was common in the eighteenth century), Ritter put forward a dynamic, organic model of galvanism. He spoke of a general force, not of one just limited to animals, and of a force which was not to be seen in terms of the above "fluid", but rather as an "organized flow" of matter (see below section 4). It is precisely Ritter's notion of organized matter that, arguably, led galvanism out of the clutches of hypothesis. What Ritter "proves" in his 1798 *Beweis* is, as the title of the work distinctly emphasizes, that the force of galvanism is constant.

This constancy has profound implications both for an understanding of the force, and, of course, for matter theory as a whole. By his use of careful experimentation and a method of endless modifications ("Modifikationen"), reminiscent of Goethe's demand for "Vermannichfaltigung eines jeden einzelnen Versuches" in *Der Versuch als Vermittler von Objekt und Subjekt* (*41*, 13), and of Novalis's proposal for "mannichfaltigen Combinationen" in "experimentation" (*N*, 3, 427), Ritter was lead to maintain that the discovery of a "constant force" implies that galvanism is above all an organized process. From here, it is but a short step to his view that galvanism is to be understood as the life force present throughout Nature. Ritter agreed with Volta that Galvani's and Humboldt's idea of a life force in their notion of animal electricity was hypothetical, since they had given no concrete proof of its existence (*R*, 128-129) (see below, pp.303-304). However, Volta's argument against the hypothetical nature of Galvani's and Humboldt's theories was more of sophist's quibble than a far reaching statement on physical laws: he claimed, since they used extractions from living organisms, it was surely contradictory to speak of a life force in dead tissue (*153*, 173). (Volta's interests did not, in any case, as must be stressed, lie in the desire to investigate a life force; his interests clearly lay in physical electricity.) Ritter, on the other hand, impressively shows that, in order to release the notion of life from the realms of an imaginary force or purely metaphysical speculation, the inquirer had to target his sights at concrete material processes, and to seek there signs of organized processes, which could then be taken as motions of a life force. This is, arguably, Ritter's greatest feat, for he believed in a life force just as Galvani and Humboldt did, but distinct from them he believed in a more fundamental life force that spanned the strictly organic as well as the inorganic realm. It is crucially his belief in a more fundamental life force that led him to investigate the relationship between inorganic and strictly "organic" processes. Thus, electrochemistry was for him of great significance for physiological processes, and contained the highly concrete clue to the workings of the life force in organisms. In fact, to Ritter, the life force which Galvani and Humboldt were seeking, and indeed the commonly held notion of "Lebenskraft" in the eighteenth century, were part and parcel of the electrochemical force. It was, for Ritter, the same "constant" force of galvanism operating in the strict organic and inorganic realms, acting in the whole organism of Nature. Indeed, early on in the *Beweis* Ritter, even before he gives evidence of and, to his own satisfaction, "proves" the constant galvanic force, states he is searching for one unifying force:

Ich wurde immer kräftiger überzeugt, daß es nur *Eine wahre* Theorie aller Naturerscheinungen geben könne, und daß diese alle, durch die kleinsten Umstände erklären müsse (*R*, ix).

In terms of galvanic technique or repertoire, Ritter adds two other new and important items. Firstly, he pointed out the role of the conductors' affinity for oxygen in a galvanic circuit (*194*, 22-46); and secondly, he drew attention to the significance of the position of the nerve in the circuit. Regarding the first of the two new galvanic phenomena, Ritter saw how the strength of a particular conductor's affinity for oxygen was directly linked to the direction of the current in the galvanic circuit. In the second instance Ritter revealed how the nerve determined the direction of a galvanic circuit; for the muscle to contract, the current must run from the nerve-end into the muscle (*R*, 46-64). While all historians have pointed out Ritter's discovery of the importance of oxygen affinity, and hence his status as a pioneer in the field of electrochemistry, not one historian has alluded to the importance of the nerve to Ritter's galvanic theory, which makes him an equally important figure in the difficult field of notions of organization. Thus, these two new additions to the galvanist's repertoire *together* form the base of Ritter's physiological electrochemistry. He links the chemical notion of affinity with the physical notion of the direction of a force in a circuit, and consequently with the physiological notion of the nerve. It need not be observed that Ritter's account of biological processes is necessarily crude in comparison with this present century's; but his views on organization, on the other hand, are highly sophisticated. Indeed, a sign of his sophistication is its very neglect by historians, which is explained by their predominantly positivist outlook, which eschews "speculative" notions such as organization.

Moreover, Ritter's new additions to the galvanist's repertoire were not fields always linked together by scientists in the eighteenth century. For example, chemistry and physics in galvanism were for many separate phenomena: in 1798 Volta was still avoiding any chemical concepts when defining galvanism. On the other hand, another scientist, G.V.M. Fabbroni (1727-1822), saw galvanism purely in chemical terms, and avoided any electrical notions (*26*). However, Ritter's electrochemical view of matter was not without forerunners. Earlier in the eighteenth century, experiments had been carried out on the relationship of various substances to the electrical charge brought about by friction electricity, as for example in the works of Benjamin Franklin (1706-1790) and William Henley (*194*, 22-23). Volta himself had drawn up a table of the most effective galvanic substances in 1792/93 and Christian Heinrich Pfaff (1773-1852) and Philipp Michealis similarly linked the strength of contractions of the frogs' legs to the particular metals (*194*, 24-25; *81*; *72*). Humboldt, also, in his work of 1797, *Versuche über die gereizte Muskel- und Nervenfaser nebst Vermuthungen über den chemischen Proceß des Lebens in der Thier- und Pflanzenwelt* (*54*), remarked much on the effect of chemical substances on galvanism. Matter and force were continually being linked but not in Ritter's sense of an organized dynamic process. However, Schelling offered an important precedent for such an approach, since he speculatively linked chemical substances and physical forces in his *Ideen zu einer Philosophie der Natur*, where he locates the continuity of electrical behaviour and chemical activity:

> Da die elektrische Materie nichts anderes ist als eine zerlegte Lebensluft, so werden alle Körper Anziehung gegen sie beweisen, die gegen Wärme und Oxygene Anziehung beweisen (*106*, 136).

This theory of Schelling's, however, remains speculative. In distinction to these forerunners, what Ritter achieves in the *Beweis*, is, as indicated, a more precise basis for such a hypothesis, building it on a knowledge of the electrochemical activity within galvanic circuits.

In the *Beweis* Ritter makes it quite clear that he disagrees with Humboldt, who is essentially a supporter of Galvani (*153*, 173), and that he sides with Volta, although with many reservations. Ritter admired Volta's physical interpretation of galvanism primarily because it linked the mysterious force of galvanism with an ubiquitous force, electricity (although Volta's theory excluded any notion of an organic life force). Indeed, in some respects, Ritter's notion of galvanism is an organic extension of Volta's physical electrical model. Notably, Ritter is in accord with Volta's two laws of galvanism, and goes to great lengths to defend the laws against Humboldt's attacks (see below, p.304). Ritter reiterates Volta's two laws in the *Beweis*:

> Die ... Gesetze für die Bedingungen, unter welchen in einer Galvanischen Kette Action oder nicht, entstehen kann, sind kürzlich diese:

*1) In jeder Galvanischen Kette, in deren Peripherie zwey Punkte vorhanden sind, durch welche jene getheilt, in zwey Hälften zerfällt, in welchen, wenn man von einem der Theilungspunkte ausgeht, die Bestimmungsgründe für die Actionen der Folge und dem Grade nach genau dieselben sind, hat keine Action statt.*

*2) Nur in dem entgegengesetzten Fall ist die Möglichkeit activer Galvanischer Ketten enthalten, und zwar sind zur ihrer Bildung wenigstens drey der Qualität nach verschiedene Galvanische Leiter, unter denen sich wenigstens einer im feuchten oder flüssigen Zustande befinden muß, nothwendig* (*R*, 33).

The first law states the condition for an inactive circuit: no action occurs when the forces inherent within the conductors on two sides of a galvanic circuit cancel each other out. The other law states that a galvanic circuit must be made of at least three heterogeneous conductors, where one of them must be a fluid or solid conductor, i.e. for galvanism to take place there must be a mixture of solid and fluid conductors (what Volta calls first and second class conductors). Ritter then supported Volta's notion of heterogeneity, and more importantly Volta's idea of a circuit, since this opened up the way to view the whole of nature as a circuit. Although Ritter appears to be extending Volta's notion of galvanism, Ritter's views are none the less deeply at odds with Volta's. Ritter agrees with Volta that the galvanic circuit has to be closed, but his notion of a constant force running through closed circuits conflicts with Volta's mechanist notion of contact electricity. It was not just that Volta's notion of galvanism would have deprived Ritter of his concept of an organizing force, for even at the strict empirical level Volta's theory seemed inadequate. Volta's static model did not explain the chemical and electrical phenomena together, and more crucially, for one of the main aims of the *Beweis*, Volta's model made no attempt to understand the electrochemistry of physiology.[3]

Volta viewed galvanic physiology in mechanist terms, as mentioned earlier; to him, the organic tissues were analogous to dissimilar metals. Volta avoided directing his attention at the workings of nerves and muscles, he did not allow any notions of an "organism" to affect his concept of galvanism. He clung to his belief in contact electricity even when Galvani's experiments showed that there was a phenomenon that could be called "animal electricity". Galvani's experiments did not prove that there was an inherent "animal electricity", nor did they prove the existence of an electrical fluid; however, they did prove that galvanism could not be reduced to "metallic" electricity. Volta's silence over such subjects as the electric fish meant that he never really perceived an organic view of force (*194*, 42; *153*, 161, 176). Indeed, in defending his theory of contact electricity as the proper explanation of galvanic phenomena, he blocked physiology out. Contact electricity necessarily implies a static model of forces and nature, and it is precisely the organic view of phenomena, the notion that things are "living" and changing, that gives rise to Ritter's organized and dynamic electrochemical theory of matter in the *Beweis*.

Indeed, primarily through his notion of organization, Ritter's concept of a "constant force" foresaw how the Voltaic battery was to work as the process of the electrochemical solution. It was not strictly felt necessary to explain the battery in terms of organization, or indeed in terms of Schelling's dynamic polarities, since Volta's mechanist terminology of "poles" was commonly accepted (*194*, 42). For a deep level of matter theory, and hence, for the development of the science of electrochemistry, Ritter's notion of a constant force has profound implications. Ritter's theory naturally entails, as does Schelling's, that an electrochemical solution must be regarded as a dynamic process; and, indeed the proof of this came later, when it was recognized that there was a constant tension ("Spannung") between the poles of the Voltaic battery (*194*, 74f.). Later in 1801, Ritter alludes to a dynamic, organized electrochemical solution:

Die ganze Batterie ist ein Meer von Oxygenität, ein Ocean von Hydrogenität (*96*; *98*, 2, 160).

To Ritter, the battery is a laboratory model of greater, organized natural processes. Thus, importantly, as must be emphasized, Ritter's broad organic account of the battery paved his way in understanding electrochemical processes.

It is interesting to note that in 1800 when Volta had invented his pile he was in no position to explain it, and so in 1801 when many scientists were attempting to explain the Voltaic pile, Ritter had by far the most explanatory account. Ritter's account came out in May 1801, well before Volta's lectures in Paris in November and December 1801.[4] But because Ritter was young and Volta more senior and renowned, Ritter's explanation was not well received, even though Volta's interpretation was far from being explanatory. Ritter also admits he had the means to invent the pile as well, and that he was very close to discovering it;[5] certainly, in his galvanic theory he was the experimenter who came closest to predicting and inventing the pile (*194*, 42f., 74f.).

Although Ritter, in his galvanic work, appears to owe much to physical and chemical notions, as indicated, for instance, in the importance of the physical idea of a circuit for his own notion of the vast organic circuit of Nature, Ritter also owes much to the other traditions behind galvanism, those of physiology and animal electricity. It has been made apparent how the notion of a life force is cardinal to Ritter's theory of a physiological electrochemistry, yet what distinguishes him from Galvani and Humboldt is their vital materialism, espoused in their belief in a nerve fluid. Ritter refers to Humboldt's notion of a nerve fluid as hypothetical (*R*, 128-129). He also called Humboldt's materialist way of viewing matter "absolut", and here "absolut" refers to a substantial notion of matter (*R*, 128). It must be added that Humboldt's great strength lay in his geological and biogeological work. In his work on galvanism he indeed achieved significant results, which must also have influenced Ritter, but galvanism or physics were not the central concern of his inquiries. Perhaps it was that Humboldt had not reflected to the same extent over notions of organization in the case of galvanism as he clearly did later, and so thoroughly, in his biogeological work. Indeed, it was common at the time to view matter in the light of Lavoisier's new chemistry, which was an "elemental", analytical chemistry. As mentioned (see above p.259), Lavoisier's chemistry did not look deeper into matter than the quality of a substance; his chemistry avoided looking into the underlying forces of matter and neglected to observe how matter was dependent upon inner arrangements and not, as he thought, dependent upon certain properties of its components. It is in this sense of "elemental" chemistry that Ritter calls Humboldt's notion of chemical substances "absolut". Humboldt applies this substantial notion of chemical substances to his galvanic theory to propound the view that chemical matter itself was a cause of galvanic action: this to Ritter was a superficial, materialist view of galvanism; for Ritter believed that it was not just particular substances which caused the frog legs to contract, it was the underlying dynamic process within matter itself. Ritter uses the term "absolut" to denote how, in his opinion, Humboldt holds a dogmatic view of matter; for the employment of a substantial view of matter and a postulated life force are, in effect, the logical outcome of one another. As soon as a life force is stipulated, or vice-versa, a substantial view of matter is put forward, then one can only think in terms of "absolute", discrete substances, or, accordingly, an "absolute", hypothetical life force. In defining matter or the life force as separate factors in galvanic processes, the possibility of viewing matter and forces in unison is blocked off. In essence, then, the inquirer has, from the outset of his investigations, to have an open, deeper view of matter, and not an "absolute" one. Thus, if matter is not considered materialistically, but, instead, if a possibility of organization is assumed in matter itself, and not in an "external" life force, the doors are opened to deep level matter theory, which, in Ritter's case, accounts for the internal dynamic processes of matter. The materialist substance theories, although postulating a life force in animal electricity, did not, then, particularly inspire Ritter. What they did though was to keep Ritter's sights aimed at physiology and the notion of "organization".

In viewing galvanic processes in terms of the separate factors of a life force and substantial matter Galvani's and Humboldt's vital materialism consequently implied that galvanism was not a universal force. It is here that Ritter sides more with Volta and defends him against Humboldt. Humboldt claimed to have proven an inherent animal electricity by revealing that some electrical conductors were not conductors of galvanism. Ritter shows in the *Beweis* that Humboldt's results can be explained by the inability of some conductors to reveal themselves because the currents may be too low to allow the frog legs to contract (*R*, 34-40). Ritter does not go so far in the *Beweis* of 1798 as to equate galvanism with electricity (*R*, 34): he obviously sees their similarities, but, essentially, he sees galvanism as a mixture of electricity and chemistry. He sees galvanism as the grand life force within which the other forces were at work. The notion of a closed circuit, derived from physical electricity, was vital to maintain the notion of a universal galvanic force. Ritter points out how Humboldt, in his *Versuche über die gereizte Muskel- und Nervenfaser nebst Vermuthungen über den chemischen Proceß des Lebens in der Thier- und Pflanzenwelt* (*54*), again drew up discrepancies to argue for an inherent animal electricity by stating that galvanic action could occur in open circuits. Ritter swiftly discounted this and showed how active open circuits were dependent upon the relative "irritability" of the organic tissue: if the frog legs were highly "irritable" they would indeed contract in an open circuit (*R*, 42-45).

This external, substantial vision of Humboldt's was indeed what hindered him in making the link between animal electricity and physical electricity in Ritter's sense, and meant that he did not develop Ritter's notion of physiological electrochemistry.

Furthermore, to place Humboldt in the broader contemporary context, it is little wonder that the supporters of Galvani felt they had to remain silent about animal electricity towards the end of the eighteenth century in the face of Volta's criticism and his now dominating notion of physical electricity (*153*, 175). Humboldt's work of 1797 was a bold step in this context, but, in 1800, when the Voltaic pile was invented, Humboldt's concept of "animal" electricity was a far cry from Volta's now "proven" concept of contact electricity based upon a physical, mechanist model of electricity. Humboldt's model of animal electricity was not based in any way upon physical electricity, but rather on chemistry alone (*153*, 175). Explanations of electricity were now, in general, no longer searched for in physiology (or, in Humboldt's sense, in a chemistry of physiology), but instead in the area of physics and chemistry. Before 1800 and the invention of the Voltaic pile animal electricity had indeed created interest for its uncovering of an electrical life force, for its physiological implications for the nervous system, and for its supposed medicinal uses (*153*, 175). But its ability to contribute to electrical inquiry was entirely overshadowed by the Voltaic pile with all its immense practical and technological implications. Moreover, Humboldt's vital materialist notions could add little to the discussion of electricity because of the hypothetical nature of the inherent electrical nerve fluid. Ritter's dynamic and organic model of physiological electrochemistry however could contribute to the electrical debate because there was nothing hypothetical about his link between the conductors' affinity for oxygen and the electrical action, nor in the role of the nerve in conditioning the direction of the current, nor was there anything hypothetical about the constant force he "proved" through his meticulous experiments.

Ritter indeed kept physiology in the debate on electricity in 1798 because he was dissatisfied with Volta's mechanist model of nature and wished to prove the universality of the galvanic life force in both the inorganic and organic realms. By 1801, however, Ritter had enough material on the inorganic realm to be able to defend his particular dynamic theory of the Voltaic pile without directly resorting to examples from the organic realm, although he does still of course draw analogies between the inorganic and the organic. And indeed for the rest of his life, as well as pursuing strictly physical and chemical subjects, Ritter also pursues the electrochemistry of physiology and stimulation physiology. In this manner, the fundamental notion of the galvanic "All-Thier" (*R*, 171), the idea that the world is a purposive galvanic entity, is taken up in his later studies. In his work of 1805, *Das elektrische System der Körper* (*97*), the "All-Thier" becomes an electrical entity. As Wetzels remarks, in this work Ritter investigates periodicity in nature, and sees the pulse rate of the "cosmic animal", the earth, as 365 days - its orbit around the sun. Furthermore, galvanic action is viewed in terms of oscillations, which are seen to mirror planetary cycles (*291*, 205-206). Unlike the *Beweis*, this later work is far less empirical. In order to construct the world's electrical system, Ritter had, as Wetzels remarks, to resort to "generous extrapolations" (*291*, 205). In Ritter's final work, published posthumously in 1811, 'Elektrische Versuche an der Mimosa pudica L. in Parallele mit gleichen Versuche an Fröschen' (*100*), the notion of the "All-Thier" is rehearsed again, not in terms of physics, but in a biological context. This work also has far more the empirical qualities of the *Beweis*. Ritter investigates the effects of electricity on plants (as a type of irritability) to come to the view that plants and animals are inverse forms of each other:

So scheint also, in Hinsicht auf ihre Structur oder ihren Bau, die Pflanze geradezu als das umgekehrte Thier (*100*, 356).

As Wetzels remarks, Ritter illustrates the correspondences between plant and animal organs in the light of their reaction to electrical stimulation: in this manner Ritter is once again arguing that natural phenomena form a whole (*291*, 69).

Ritter's galvanic work and his status as a scientist were at the early stage of his career acknowledged by the scientific community. From the summer of 1798 up to the winter of 1799/1800 he was taken on by A.N.Scherer (1771-1824), worked in the latter's laboratory in Weimar, and assisted him in bringing out the *Allgemeines Journal der Chemie* (*5*; *142*, 9). L.W.Gilbert (1769-1824), the editor of the *Annalen der Physik* (*6*), had great respect for Ritter.[6] H.C.Oersted (1777-1851) was deeply impressed by Ritter's *Beweis* and remarked:

Es ist nicht gut geschrieben, aber die Worte darin sind vortrefflich und die Beweise mit einer Strenge durchgeführt, die ich größer bei keinem physikalischen Schriftsteller gefunden habe, und eigentlich muß ich bekennen, daß ich beim ersten Durchlesen just in die gleiche Stimmung versetzt wurde wie damals, als ich Euklid das erste Mal las (*78*, 77).

Goethe too speaks of Ritter with the highest of praise:

Rittern habe ich gestern [*28.9.1800*] bei mir gesehen, es ist eine Erscheinung zum Erstaunen, ein wahrer Wissenshimmel auf Erden (*39*, IV, 15, 123).

However, although Ritter made a considerable impact on the scientific community in 1798, his account of the Voltaic pile in 1801 met, as mentioned, with little response. His notions had no sway against Volta's authority and against the notion of contact electricity. Yet Ritter's achievements gain status when it is considered what he had to struggle against in the contemporary context. Ritter's theories were born just when Volta's theory of electricity was strongly dominating the sciences. It was many years before Volta's notion of contact electricity was replaced by Michael Faraday's (1791-1867) theories, which Faraday proposed in 1840 (*194*, 45). It could therefore be said that Ritter's electrochemistry, in having important implications for a dynamic theory of matter, was simply ahead of its time; similarly, as mentioned, his notion of a "constant force" can be seen as some sort of forerunner of the notion of the conservation of energy. One must also view Ritter's theories in the light of the fact that physiological electricity itself went through a long eclipse, only reviving again much later. For an interest in animal electricity itself, in the sense of electrophysiology (as opposed to electrochemistry), arose in the mid-nineteenth century in the works of du Bois-Reymond (1818-1896), Ludimar Hermann (1838-1914) and Hermann Helmholtz (1821-1894) (*153*, 209-211). Admittedly, the study of animal electricity had poor "scientific" status at the end of the eighteenth century because there was no way of measuring it quantitatively; the subject was swept aside by the growing precision and technology of physical electricity. This "quantitative" factor, coupled with purely speculative notions of a life force, such as Humboldt's, and coupled with a dynamic matter theory, such as Ritter's, which ran against the tide of the matter theory of "elemental" chemistry, also help explain the decline in interest in animal electricity, and convey the difficult atmosphere in which Ritter had to operate. Furthermore one can say generally that the positivist tendencies of the emerging new sciences of the time easily obfuscate just how resourceful Ritter was in 1798, having to use crude techniques and having to compete against a less complex but widely accepted theory of matter. The ability to argue for organic dynamism in that climate is an achievement in itself, and on all accounts his early success was well acclaimed, even if after 1803/1804 the scientific community hardened against him. Yet, although the community in general turned against him, Ritter did still continue to be of significance to some major thinkers, as the historian Williams remarks when he argues for Ritter as the key to understanding the sciences of the early nineteenth century:

Foremost is an understanding of Ritter's work, for it runs constantly through the literature of the day. His influence on Hans Christian Oersted was enormous; Davy quotes him frequently; and even Faraday ... refers again and again to his work (*295*, 4).

It is important that in 1798 Ritter was really studying not electrochemistry or animal electricity themselves but a combination of the two, an electrochemical physiology. Ritter essentially worked on a hypothesis concerning the electrochemical physiology of the nerve, where, although he could not possibly have known the internal composition of the nerve, he did "prove" that nerve action was based upon a "constant force" and a process within matter. Ritter approached the subject of organization as closely as he could through electrochemistry and notions of physical electricity. These electrochemical and physical implications can be seen most explicitly in the experiments on the various conductors' affinity to oxygen (*R*, 46-76), for his experiments here reveal how chemical affinity was a major factor effecting galvanic processes. The strength of the particular conductor's affinity for oxygen affected the strength of the contractions of the frog legs and the direction of the current in the circuit (naturally these electrochemical and physical implications are also implicit in all the experiments). Further, the "physical" implication of the nerve is made apparent throughout his experiments, since the nerve plays an important role in conditioning the direction of the current. Finally, in those experiments where Ritter carefully "modifies" the galvanic circuits an internal "constant galvanic force" is made visible through the contractions of the frog legs (particularly *figures 67-72, 75* and *76* ; *R*, 113-116, 147-154). Here, in these highly significant experiments, Ritter argues for the physical and electrochemical factors in nerve action. Ritter's notion of organization is thus continually linked to electrochemical and physical phenomena through his strict observations of their effects on the frog legs, and indeed, through his observations on their effects on his own body in his experiments concerning stimulation physiology.

Linking physics, chemistry and physiology to life through the notion of a "constant force" was a major step to take in 1798, and it was a long time before the field of electrochemical physiology (in distinction to electrophysiology) or, as it is today called, bioelectrochemistry, was opened up. The exact nature of the electrochemical processes of life obviously could not be proven outrightly in terms of physiology in 1798, but Ritter felt sure that the inner dynamic relationships of conductors in a circuit held the key to the understanding of the electrochemistry of life, and importantly the "life" of electrochemistry. This is a point where he is in fact at odds with modern bioelectrochemistry: to him Nature, as indicated, was one immense electrochemical dynamic organism. The key to purposiveness in natural phenomena lay in the "organized" electrochemistry of the "Organischen ALL" (*R*, 171).

*3. The aim of the* Beweis.

In Ritter's hands in 1798 galvanism came to mean, then, a dynamic electrochemical life force which acted in both the organic and inorganic realms. The *Beweis* first sets out to prove a constant galvanic force in the organic realm, and then moves on in the last sections to speculate generally about galvanic theory (*R*, § 25-28, 159-174). It is here that Ritter speculates that "galvanism" is present throughout Nature. He actually goes deeper into inorganic galvanism in 1799 in his *Beweis, daß der Galvanismus auch in der anorgischen Natur zugegen sey* (*94*; *98*, 1, 139-164), but it is already clear in the earlier sections of the *Beweis* of 1798 that the experiments concerning oxygen affinity (*R*, 46-76) and those experiments revealing how inorganic conductors are part of the general dynamic galvanic process (*figures 75-76*: *R*, 147-154), are more than just a step towards an inorganic understanding of galvanism.

The whole point of "proving" that galvanism constantly "attends life in the animal kingdom" is not primarily, as Wetzels puts it, to demonstrate that galvanism can take place without metals (*292*, 202) - the implication being that Ritter above all desired to show that galvanism occurred in the organic realm. This is clearly not Ritter's true aim. Both implicitly and explicitly he is searching for material to substantiate his notion that galvanism is the universal force of both the organic and inorganic realms.

In this sense, the notion of galvanism as a force in the inorganic realm is clearly implicit throughout the *Beweis*, since nearly all the experiments deal with circuits composed of both organic and inorganic conductors. In the early part of the *Beweis* Ritter is mainly concerned with investigating the link of oxygen affinity to galvanism and with considering the direction of the galvanic force. It is only later in the *Beweis* after "proving" the constant force of galvanism (in *figures 67 to 77*), that Ritter deals with inorganic conductors explicitly as part of a dynamic galvanic whole (*figures 75 and 76*). *Figures 75* and *76* show particularly how inorganic conductors are part of the circuits and how they affect the dynamics of the circuit. For the key phrase in the title of Ritter's 1798 work is the notion of a "constant force"; proving a general dynamic force in the organic realm necessarily implies that the force operates in the inorganic realm. The use of a series of metal conductors in *figure 75* (*R*, 152) shows how Volta's undynamic, static model of galvanism did not explain the phenomenon entirely. In *figure 75*, the galvanic force does not just arise from the touch of the metal, for here Ritter reveals how there is always a constant force in the entire closed circuit. Indeed, both Volta's and Humboldt's "elemental", substantial views are refuted here.

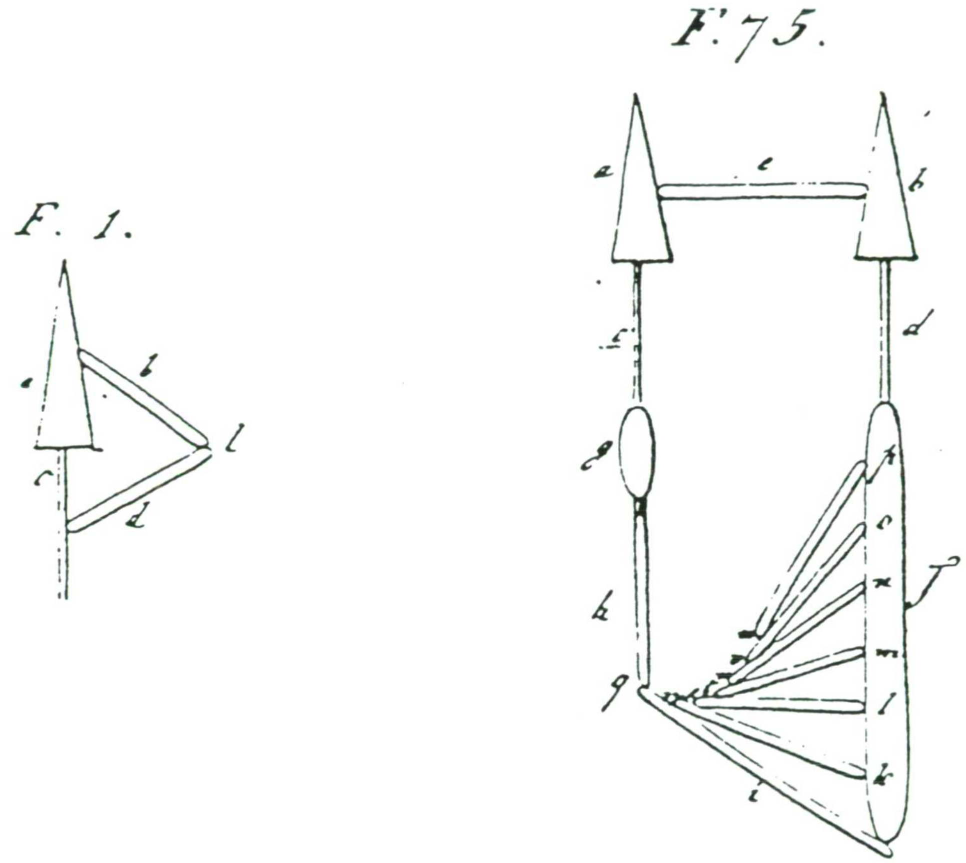



*Fig.4. Ritter's galvanic diagrams, figures 1 and 75 (Beweis, 1798).*

*Figure 75* represents a highly complex form of Ritter's galvanic experiments. *Figure 1* shows the fundamental form of the experiments, where *a* is the muscle of the frog's leg (Musculus gastrocnemius), *c* the sciatic nerve, *b* and *d* are metals, and *l* is their point of contact. As in all the experiments, the frog's leg is used as a measuring device, a physiological electroscope, to test the presence of a current by observing the strength of the muscle's contractions. In Ritter's day, there were no other means of measuring the minute currents in the galvanic experiments. If in *figure 75* the circuit is closed in q and the various metals ("Bley *k* ... Zinn *l*, Eisen *m*, Kupfer *n*, Wismuth *o*, und Silber *p* ..." (*R*, 151)) are added there is no "action". But by adding the metals and *then* closing the circuit, "action" does take place. The experiment therefore reveals that in what appears to be an inactive circuit there is indeed "action"; it also importantly implies that the force in the circuit is not reliant upon conductors alone, that is upon the addition of the metals, but upon the constant force in the whole of the circuit, i.e. the dynamic relationship and behaviour of all the conductors, and how they effect one another and the circuit as a whole. For the constant force is invisible when the conductors are introduced after closing in *q*, but visible to the experimenter (through the contractions of the frog legs) when the metals are added before closing in *q*. The experiments reveal that there is always a finite force ("Action") in closed circuits, even if there are no contractions:

Hier wird offenbar ein Etwas, ein $> x$ [*x is the "action" in a circuit*] zerlegt in *n* Theile, deren jeder gleich $< x$ ist. Es wird getheilt, und die Theilung ist endlich, damit auch der Theil, nie kann er übergehen in Nichts, immer bleibt er Etwas ... (*R*, 152-153).

The metals are varied, each one apparently exhausting the force in the circuit, yet the introduction of a new metal to the circuit shows how a constant force is still present in the circuit which works with the new metal conductor to produce "Action". To Ritter, there is no such thing as an exhausted circuit, for there will always be a certain force present, however minute. Thus Ritter argues that the cause of "action" is not the contact of Volta's metals: the prime principle of galvanism is the "constant force", in relation to which the metals are merely relative. Thus *figure 75* confirms that the constant dynamic force is always in action, even if the addition of metal to the circuit produces no visible "action". Hence, at the end of the empirical section of the *Beweis*, Ritter views the inorganic substances as part of the galvanic process, and demonstrates how they effect the process, and how the "action" of the inorganic conductors themselves is dependent on the dynamics of the whole circuit. At this point, Ritter explicitly refers to the application of galvanism to inorganic substances as well as to organic ones, when at the end of the experiments based on *figures 75* and *76* he concludes (on the "proof" of a "constant force" even in apparently inactive circuits):

Unser Beweis gilt also durchaus für *jede* Galvanische Kette, welcher Art sie auch sey ... (*R*, 153).

In effect, Ritter's belief in a universal galvanic force of the organic and inorganic realms positions him between Galvani and Volta, although, naturally, Ritter's particular dynamism makes him more than just a mediator between the two other galvanists. In the context of Galvani's and Volta's theories, Ritter demonstrates how Galvani's notion of animal electricity operates in the same way as physical electricity; that is, in Ritter's view the galvanic force operates in closed circuits with inorganic conductors as well. Furthermore, he demonstrates that Volta's notion of contact electricity is due not just to the metals (or inorganic conductors in general), but to a constant force in the entire circuit composed of organic and inorganic conductors.

Due to the strength of Volta's theory of contact electricity, Ritter had to make it especially clear that there was a force attributable to the organic tissue itself within circuits containing both organic and inorganic conductors.[7] In order to do this Ritter had to conduct experiments with alterations to the organic tissue alone. Of course, Galvani had already shown that some form of physiological electricity existed. He did this in his experiment which uses only the muscle and nerve of a frog's leg to produce galvanic action (*36*; *153*, 172). There is, however, a marked difference between Galvani's experiment and what are Ritter's most important experiments for his "proof" of a constant force (*figures 67-71*; *R*, 113-114). Most obviously, Ritter's new view of galvanism as electrochemical organization meant his experiments had to use organic tissues but account for them in an 'inorganic' way, that is, he had to show that the organic tissue was part of the whole electrochemical circuit, and that both the organic and the inorganic conductors played a role in creating the organizing force in a circuit. In practice, this entailed his having to find some way of revealing a force within organisms while at the same time having inorganic conductors in the galvanic circuit as well.

It was Ritter's belief in the general organized dynamic process of Nature that enabled him to approach the organic in terms of a broad notion of the inorganic, and, as also mentioned, importantly, he interprets Volta's physical laws of heterogeneity and closed circuits in terms of an organizing life force. With the same approach Ritter interprets dynamism (which treats "Physik" and matter, i.e. the inorganic) in terms of organization. In the speculative section at the end of the *Beweis*, Ritter indeed speaks in the dynamist terminology of thinkers such as Kant and Schelling, describing substances as "Raumerfüllungs-Individuen" ("space-filling individuals").[8] Ritter describes a chemical action as one where two different "space-filling individuals" unite to produce a single new "individual" (*R*, 173). The electrical process takes place where two "individuals" act upon each other directly, but restore their dynamic equilibrium without producing a single new "individual", or more precisely, as Ritter expresses it, the qualitative difference of the two substances does not go through an entire transition into a new qualitative unity: "*ohne gänzlichen* Uebergang der Differenz zur Einheit" (*R*, 172-173). Galvanism is described as a process where three "individuals" act upon each other directly and indirectly (i.e. the conductors touch one conductor but not the other) without producing a new unity:

*ohne gänzlichen* Uebergang der Dreyheit in Einheit (der Qualität) ... und zwar jedes auf das andere *unmittel- und zugleich mittelbar* wirken könnten (*R*, 172).

Thus, when drawing up and interpreting Volta's laws of galvanism Ritter refers to forces in the circuit as "dynamische Circulation", and speaks of Nature's balancing activity:

*Sie [the conductors] mußten verschiedener Qualität seyn; denn erst damit sind überhaupt Bestimmungsgründe für Thätigkeit gegeben.* Alles Handeln in der Natur geht auf *Gleichgewicht* aus. Bey *homogener* Qualität ist aber schon Gleichgewicht mit sich selbst da, und der *Grund für Thätigkeit fehlt* (*R*, 156).

It can be seen that Ritter inserts a concrete notion of organization both into Volta's physical electricity and into dynamism. Dynamic forces are given material form by being seen as processes within matter, and Volta's physical and mechanist heterogeneity is intepreted as a sensible activity of Nature, driving matter back into a homogeneous balance of unity. Ritter succeeds both in giving the hotly disputed dynamic theory of matter substantiality and in accounting for the organic in an "inorganic" way. Ritter demonstrates how galvanic processes occur invisibly and inwardly in a dynamic sense, and not merely in an external visible change in the circuit, and he gives physical electricity more breadth by viewing electricity and galvanism in terms of organization throughout Nature, and does not just see the causes of galvanism lying in mechanical contact electricity.

In practice, he achieves this confirmation of an organized dynamic process of matter by meticulously modifying his circuits made up of both organic and inorganic conductors, and, as mentioned (p.313 above), he had to turn his skills particularly to the organic part of the circuit to prove that there was an electricity within animals which was undergoing the same universal galvanic processes as the inorganic conductors. In this way, and in opposition to Galvani, Ritter could reveal not a vital substance, but a dynamic life force bound up in matter itself. Galvani's fundamental experiment (*36*) served to demonstrate external activity, in the sense that, although Galvani's nerve fluid is a notion of an internal action, Galvani's experiment only interprets internal action "materialistically" in the light of something taking place "externally". For Ritter's modifications to the circuits in *figures 67-71* demonstrate that there is a constant internal dynamic force *in* the circuits. In contrast to Galvani's crucial experiment which showed how animal electricity came into action through the contact of two parts of an organic circuit, Ritter's experiments show how that, *without* making a break in the circuit, there is a constant force in galvanic circuits: the point being that the galvanic force does not have to display itself externally ("materialistically") in the form of a new contact (i.e. breaking the circuit and *then* making a new contact), but that the galvanic force occurs internally in matter as part of an inner invisible dynamic process. The experiments in *figures 67-71* give visible "proof" of invisible processes in the circuits. Initially, all the circuits in *figures 67-71* are referred to as inactive; it appears when contact is made with, for example, the metal conductors, that there is no more force in the circuit, the frogs legs do not contract. However when the organic part of a *whole* circuit is altered, not by breaking the circuit and making a new point of contact, but merely by changing the shape and points of contact of the organic part of a whole circuit, contractions do take place. The circuit is viewed as a whole, within which internal change in the whole takes place, as opposed to a circuit where "externally" new points of contact are made: the notion of conductors is thus relativized, and the notion of a whole circuit is stressed. Merely by changing the form of a whole circuit, not by "externally" making a new contact, and thereby bringing a new supply of force to the circuit, Ritter reveals that a galvanic process can take place (these experiments are dealt with in detail below in section 4). The experiments thus imply that there must have been some force already present in the circuit not caused by any form of contact "external" to the circuit, and that by merely rearranging the structure of the circuits the components of the circuits now stand in a different spatial relationship to one another and that the new positions of the components of the circuits produced in themselves enough force to make the muscle contract. It is importantly on alterations to the organic part of the circuit that Ritter bases his argument, and this was clearly his strategy in the *Beweis*. By altering the organic part of a circuit containing inorganic conductors as well, he could reveal a force within organisms that was affecting the inner dynamics of the entire circuit. Thus, he could show that the organic tissue was part of the whole electrochemical circuit, and that both the organic and the inorganic conductors played a role in creating the "constant force" in a circuit. It is Ritter's ultimate aim to show that behind his "proof" that galvanism attends the process of life in the animal kingdom lies the further "proof" of a deep level matter theory for the inorganic (both in the sense of a constant "Spannung" and of inorganic "organization"), which could not, at that point of inquiry in Ritter's day, be shown by employing just inorganic conductors. Hence it is the alterations to the organic part of the circuit which are of such great significance to Ritter, for therein, in his view, lay the "proof" of a general organizing force applicable to Nature in her entirety, of both the organic and inorganic realms. For Volta's experiments could only account for a mechanical view of matter, and investigators such as Humboldt and Galvani could only account for organization in terms of a hypothetical force. Through his experiments Ritter could show that galvanism was not caused by a materialist "fluid", nor was galvanism merely brought about by the touch of two metals and the mechanist notion of contact electricity, nor, indeed, merely by the touch of organic parts. Galvanism was essentially a "constant" internal process in matter, in the inorganic and organic realms, a process based as much on a physical force, as on chemical substances themselves, and as on a life force itself; for Ritter spans both physics, chemistry and the notion of a life force in his own idea of organized electrochemistry. The key to his "proof" was the nerve, for Ritter based his "proof" on alterations to the organic part of the circuit by employing the nerve in particular. His exact use of the nerve needs now to be treated more thoroughly.

*4. The significance of the nerve for galvanic theory.*

Ritter succeeded in making advances in galvanic theory primarily through his work on the nerve and his particular approach to the nerve. It was common at the end of the eighteenth century to refer to nerve action as an instance of "Reproductionskraft", or as Ritter appears to call this force, "Propagation" (*R*, 49-50). "Reproductionskraft" was used to refer in general to a force governing the growth and reproduction within organisms.[9] "Reproductionskraft" was used to account for activity within organisms, and was held to govern life along with the other major forces of "Sensibilität" and "Irritibilität". Schelling, for instance, speaks of the notion of "Reproductionskraft" as "Bildungstrieb". The latter term was actually coined by J.F.Blumenbach (1752-1840). To Schelling, "Reproductionskraft", or "Bildungstrieb", is the "Bildungskraft" of the inorganic spurred into organic organization through the "Weltseele" (*107*, 565-566). The "Bildungstrieb", for Schelling, together with the forces of irritability and sensibility, made up life.

Ritter, however, although he appears to be employing the term "Propagation" in the sense of "Reproductionskraft", was, as indicated, in his *Beweis* searching for a general generative force throughout Nature, including the inorganic. Thus he turns to the organic part of the circuit where "organization" was commonly believed to take place, and investigates organic organization in terms of electrochemistry. For he correctly remarks that little attention had been paid to the material composition of the nerve. What happens, he questions in the *Beweis*, when instead of approaching the nerve in terms of a force allocated only to organisms, one investigates the neglected area of the inner "specific structure" of the nerve? Surely some answers to the related problems of nerve action and galvanism could be attained by analyzing the nerve in terms of the inorganic and matter theory? Not far into the *Beweis* he remarks (in a not entirely eloquent fashion):

... und dieses ist eben das merkwürdige, bey Bildung der Theorieen über den Galvanismus, aber auch eben darum zu deren großen Nachtheil, bisher fast ganz vernachläßigte Resultat, was sich aus jenen Versuchen ziehen läßt - die für Fortpflanzung jener, unmittelbar die Muskelfaser angehenden Thätigkeit - von der sehr wohl die, diese erst erregende, in der Galvanischen Kette statt habende, die an keine organische Structur u.s.w. des Leiters nothwendig gebunden ist *[the electrochemical* *action]*, und die man im Gegensatz der ersteren, die niedere, und jene *["Reproductionskraft" or "Propagation"]* die höhere nennen könnte, zu unterscheiden ist, - nöthige Bedingung, nemlich den in der specificken Structur des Nerven und dem gewissen zur Verrichtung des Nerven durchaus nöthigen örtlichen Verhältniß seiner homo- und heterogenen Theile zu einander bestehenden ungestörten organischen Zusammenhang des Sensorii mit dem zu bewegenden Muskel vermittelst seines Nerven ... (*R*, 49-50).

By demanding that the nerve be understood in terms of the physics and chemistry of galvanism, Ritter establishes the crucial link between organization within the organic realm and within the inorganic realm. The "constant galvanic force" is the single force governing the both realms, and indeed his further findings in the field of electrochemistry (i.e. not his notion of "organic" electrochemistry alone, but also his work on inorganic electrochemistry) support his view that there is "organization" within the inorganic realm as well.

Looking more closely at his experiments now we will see just how the use of the nerve in the circuits plays so important a role in his "proof". For the nerve is the organic conductor which Ritter uses to demonstrate how alterations in the organic, i.e. physiological, part of the circuit cause galvanic action. Ritter's use of the nerve crucially reveals how a change can be made in the "dynamic" structure of the circuit, thus causing galvanic action, without necessitating the addition of a new conductor.

In the experiments illustrated in *figures 67-71* (*R*, 113-114) the nerve is bent around back on itself or used in some other way to make a new point of contact and hence a change to the circuit. In *figure 67* the nerve end *d* is made to close the circuit at $\beta$ ; in *figure 68* the noose of the nerve $\beta$ closes on $\alpha$ ; in *figure 69* the double noose of the nerve closes on $\tau$ and $\delta$ ; in *figure 70* the split nerve is closed in $\alpha$; in *figure 71* the two nerves are closed at $\alpha$ and $\beta$. When these new points of contact are made "Action" takes place, and contractions follow. At one level, through the modifications to the nerve, the *whole* of the circuit is "internally" altered (without the addition of a new conductor or breaking the circuit), and, naturally, at another level, change takes place internally in the circuits in the "invisible" processes of matter.

I have gone into these experiments in some detail in order to demonstrate how

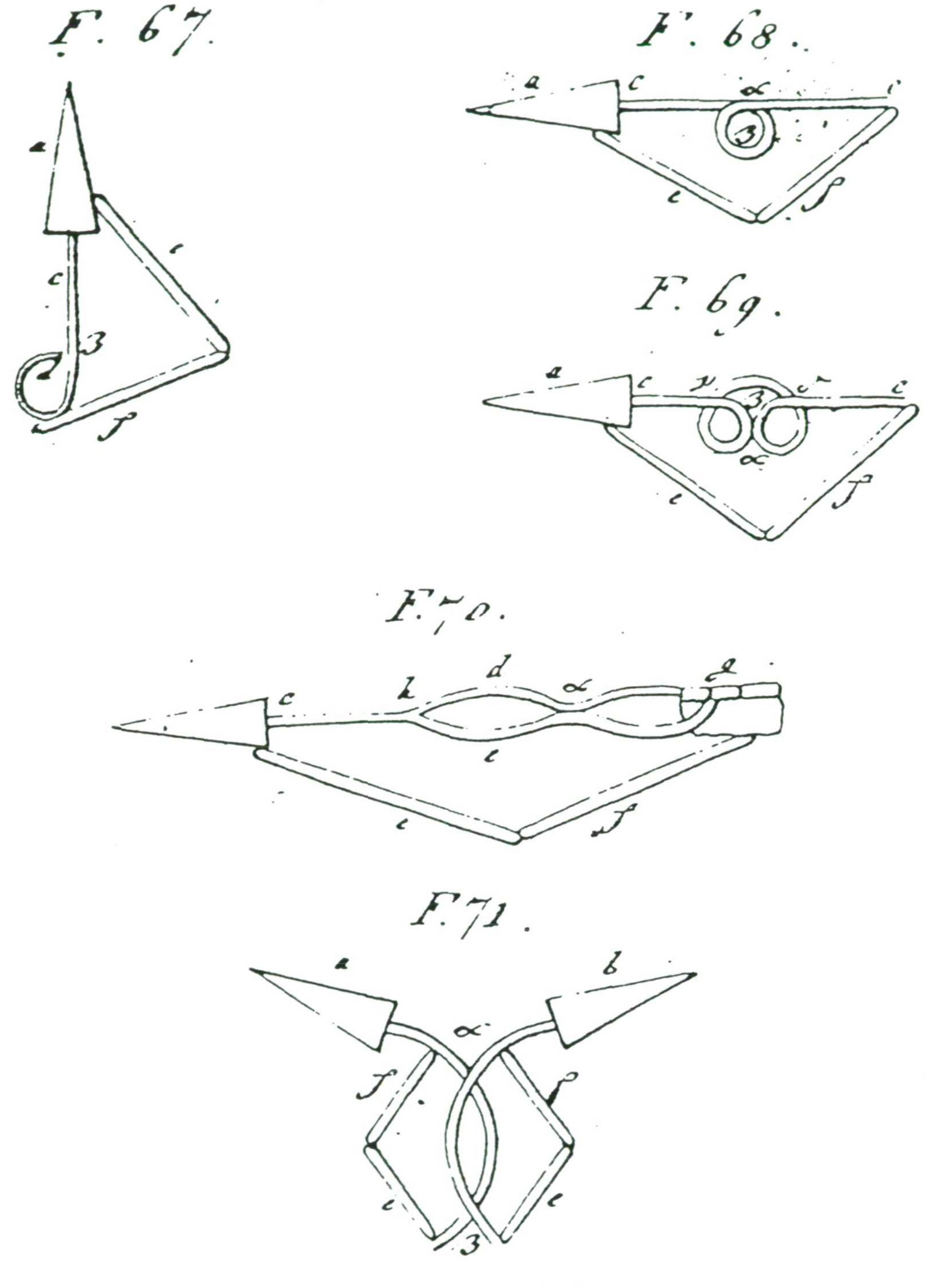



*Fig.5. Ritter's galvanic diagrams, figures 67-71 (Beweis, 1798).*

important the physical and natural philosophical issues are; it is not enough concentrating only on the physiological implications, and to interpret the experiments as an early discovery of the injury current of the nerve or of Hermann's demarcation current (*153*, 172). Galvani's experiment without the metals can also be seen in the light of physics, in distinction to physiology, in the sense that he showed there was a flow of current (*153*, 164, 172). What Ritter does, through his detailed experimental technique, is to reveal what Galvani does not, the constant current, and hence even more so than Galvani, his experiments cannot be reduced to physiology as statements on bioelectricity, since he "proves", in his view, a fundamental physical action in the circuits. It is the ability of the nerve to alter the circuit without adding anything to the circuit or breaking the circuit which plays the most important role in Ritter's "proof". The modifications to the nerve lead galvanism away from substance theory and contact forces and demonstrate how conductors, be they organic or inorganic, are relative factors in galvanic processes. The invisible internal and "organized" dynamic processes within conductors and the neglected area of the material make-up of the nerve were given concrete, visible form through the undeniable existence of the constant force. In 1798 these were indeed far reaching statements and with them Ritter attained a deserved recognition.

Further, as mentioned, Ritter's use of the nerve raises fundamental natural philosophical issues and supplies a coherent base for a natural philosophical interpretation of galvanic processes. Ritter makes no explicit comment on the greater significance of the nerve, but the importance of the nerve is implied in both his theory and practice. To those with interests in the purposiveness of natural phenomena the nerve would have attracted attention, since it causes action internally, and not externally in a mechanist sense. It would have appeared as an example of action at a distance; there was a proportional relationship between nerve-length and force, for the longer the nerve was the greater the corresponding contraction of the muscle was. The nerve was a classic case of invisible, but none the less concrete activity. Moreover, the nerve, in its role in the experiments above as an organically whole conductor, and not as a distinct conductor, could be seen to provide a clue to some vast organic closed circuit of Nature. Ritter's experiments with the *form* of the circuit point to internal activity in Nature, and the experiments suggest a link between the "organic" whole form of the nerve, as a "continual" form, with the continual force of galvanism. In this light Ritter's experiments can be interpreted as releasing theory both from strict dynamism and from atomism, and indicate that matter should be viewed as a dynamic, changing process, or what could be called a "material flow of form". By analogy, the whole of Nature is to be interpreted as a closed process where matter changes dynamically within, just as within the nerve, processes are active. The nerve in this way appears as a microcosm of Nature.

Furthermore, since Ritter had demonstrated that an organism's most developed force, the sensibility of the nerves, was based upon a general force, his work also implied a certain sensibility throughout Nature. The constant galvanic force can indeed be understood as a notion of a "world soul", akin to the purposive principle that Schelling sought in his idea of the "Weltseele". When Ritter speaks of Nature as an "All-Thier" (*R*, 171) he is, obviously, speaking not of some inert physical entity, but refers to the body and soul of a single vast purposive organism. "Die inneren (dynamischen) Verhältnisse" (*R*, 112) within matter are proof indeed to him of a universal sensibility in Nature.

A final point concerning "proof" should be made to put Ritter's "discovery" of a "constant force" into its proper perspective and to elucidate the broader natural philosophical significance of his employment of the nerve. As indicated, many of the historians of science approach Ritter from a highly positivistic stance, and refer not to his discovery of a "constant force" as such, but rather to the electrochemical implications of his work, or to the physiological aspects, such as the injury current of the nerve. The remarks above concerning the significance of the nerve for a notion of matter that seeks to bestride both dynamism and atomism go to the heart of Ritter's endeavours, for he was, in essence, attempting to "prove" a notion of deep level matter theory. The words "proof" or "prove" can only with difficulty be used in this context, and they have therefore, when this context has been referred to, been inserted in inverted commas. Obviously, in the eighteenth century the word "proof" was used more liberally than today. What Ritter was seeking to "prove", and maintained he had "proven", could not today be counted as proof itself. Yet what he was seeking to prove, on the other hand, has not been proven to this day. For deep level matter theory or the notion of organization in matter are questions which still remain unanswered. Naturally, the standards of proof are higher today, as are the methodological sophistications of verification and falsification. Inquiry has also come closer to answering those difficult questions, but this does not lessen Ritter's achievement when it is considered that he was working within the limits of his age, and that the questions he was seeking to answer were perennial ones. Today scientists are still searching for the fundamental make-up of matter, and their search manifests itself in the discovery of increasingly smaller and more fundamental particles, or in the proposal of fundamental units such as "quarks" (*216*, 120). On the other hand, some thinkers eschew particles. Gary Zukav, in his book, *The Dancing Wu-Li Masters*, suggests that the continuous existence of particles is probably illusory, and that not the particles themselves should be studied, but rather their patterns. In a highly dynamic sense, matter, in Zukav's view, is the momentary manifestation of interacting fields (*216*, 119-120; *304*). Put into this greater context, Ritter's attempt to account for a "constant force" may not be a "proof", but it is certainly a significant attempt to formulate a deep level of matter theory. The experiments with the nerve explicitly suggest a view that proposes matter is made up of an infinite amount of circuits, large and small, within which organized and dynamic processes of matter are occurring. This is a stance that does bridge atomism and dynamism, since both fundamental units are accounted for in the notion of infinite circuits, and forces are accounted for in the internal dynamics of the circuits. Furthermore, since Ritter argues for his matter theory using the nerve he stresses the idea of "living", organized matter, and not just inert matter, for the nerve, as a unit within which organized, dynamic processes occur, can be seen as symbolic of all circuits. However, it is not alone what Ritter "proved" that is of relevance to the notion of "proof", even though his findings in the context of contemporary thought are a great achievement. Of greater significance to thought today perhaps is his method of inquiry, which is, as is the main argument of this work, also a major concern of the early Romantics. However, before moving onto the important notion of Romantic practice and productivity in the Romantic notion of experimental inquiry, it is worthwhile making some tentative comments on how Novalis employed aspects of Ritter's galvanism in his natural philosophical writings of 1799 and 1800.

*5. Excursus: Galvanism and excitability*

The notion of experiment and the issues of inquiry revolving around Ritter's own method, as are to be discussed in the following sections, provide an instance of continuity in Novalis's thoughts stretching from his work in the *Freiberger naturwissenschaftliche Studien* and *Das allgemeine Brouillon* up to his later notes in 1799 and 1800. Novalis's search for a reliable method of knowledge in his earlier notes is still carried on, but not with the same intent he had when undertaking his attempt at the classification of knowledge in the encyclopaedic project in *Das allgemeine Brouillon*. It is in these later notes of 1799 and 1800 that Novalis also attempts to unite his earlier interests in excitability with Ritter's notion of galvanism. This is, admittedly, not undertaken on any large scale, but none the less Novalis's comments on these issues are significant for they give clues to his overall picture of the human state at this time. Furthermore, Novalis's remarks on excitability and galvanism could indeed be of use in interpreting his literary works since they support the view that man was a galvanic being.

Neubauer has shown how Novalis wished to make improvements to medical theory by uniting the camps of the neuro-pathologists with the humoral pathologists (*337*, 110-112). One can build on Neubauer's views to show how Novalis's knowledge of Ritter's galvanic theory also provided material for such an envisaged improvement of medical theory. Novalis argues for a pathology which takes a broad account of the inorganic, going beyond the chemical fluids of the humoral pathologists to embrace Ritter's galvanic theory, and thereby uses galvanism to support notions of organization in the inorganic. In doing so, Novalis also supplements German Brunonian notions of excitability and organization with elements arising from Ritter's theory of galvanism.

Röschlaub's alterations to Brown's notions of internal and external stimuli attracted Novalis. Brown maintained there were independent internal stimuli caused by "muscular contraction, sense, and the energy of the brain in thinking, and exciting passion and emotion" (*15*, 2, 134 f.). Röschlaub in distinction stressed the active receptivity of organisms whereby all internal stimuli were the result of the transformation of external stimuli. Naturally, Röschlaub's notion of what counted as external stimuli was correspondingly broad. It included physical impulses, thinking, the workings of the "soul" and the affections of the heart (*101*, § 1424-1425; *337*, 110). Novalis agreed with Röschlaub on this point since it implied that no distinction was to be made between physiological and psychological stimuli. They were all converted into internal stimuli through the medium of the body:

In dem *Sinn* wie Röschlaub, die innern incitirenden Potenzen nimmt, müssen alle äußre Potenzen, wozu dann auch die Seele und der Geist gehört - *mittelst* der inneren incit[irenden] Pot[enzen] wircksam seyn. D[ie] Summe der innern incitirenden Potenzen ist der Körper (*N*, 3, 352).

The grouping together of physiological and psychological impulses led Novalis to speculate on whether body fluids were animated by the soul. He even went so far as to say that the fluids were composed in varying degrees of body and soul; that is, he suggests some form of "fluid" thought:

Sollte etwa der Process der Säfteveränderung in einer *animation* der *Körpersäfte* - eine Mischung gleichsam der Seelen und Körpersäfte bestehen - Je vollk[ommner] die innern incitirenden Potenzen sind - desto vollk[ommner] geräth die Mischung und desto voll[kommner] der neuer *Anschuß*.
(Das Blut *soll* belebt seyn, und also werden.)
Die innern incitirenden Potenzen selbst sind ein Compositum - aus Seele und Körper - in mannichfachen Verhältnissen (*N*, 3, 352).

Novalis speculates that the exciting powers are contained within a "Compositum" of both mind and body. The exciting powers of the mind are part of a continual process of constitutional changes, whereby the "Körpersäfte" are animated ("animation"), and where physical change occurs ("Anschuß").

With these broader notions of excitability and organization in mind, Novalis suggested a union of humoral and neuro-pathology. Thus, although a remark such as the following appears to be referring to the strict context of German Brunonianism and humoral pathology, Novalis's final stance to pathology views thought and the soul as organized matter. Novalis observes here how humoral fluids could, in his view, be seen in terms of excitability:

Es giebt Humoralsthenieen und Asthenieen ... (*N*, 3, 311).

Thus, in terms of medical practice, the humoral pathological debilitating treatments, as for example in bloodletting, were to be interpreted in the light of Brunonian practice as a form of stimulation:

Man kann durch concrete Schwächung stärken - und umgek[ehrt] (*N*, 3, 371).

Armed with Röschlaub's notion of internal stimuli and his own concept of the excited state of the body's fluids, Novalis could then, for example, make remarks such as the following one, which claim very specific links between mind and matter:

Über die vorzügliche Wirckung mancher *Gemüthsaffecten* auf bes[ondre] Organe. Diese Betrachtung kann uns unendlich instructiv werden. So wirckt der Aerger z.B. auf d[ie] Galle etc (*N*, 3, 351).

Although, as Neubauer remarks, Novalis was essentially on the sides of the Brunonians, he believed that the Brunonians reduced pathology to symptoms, thereby overlooking the fact that the course of the diseases could lie in the fluids of the body as well (*N*, 3, 377; *337*, 110-111). Thus Novalis points out that Röschlaub had omitted the category of "Indirecte Sthenie" (*N*, 3, 327), a category which refers to a state caused by lack of stimulants and not purely to some inherent state of excitability. Indeed, in some remarks early in 1798 on the "constitution" and excitability theory (the other remarks on these subjects cited here were made in the last half of 1798 or later), Novalis speaks of "C(onstitution) mit mangelnder Incitation (indirekt sthenisch)" (*N*, 2, 573).[10] This extends Brown's categories of excitability by introducing a fourth type of disease (*337*, 72). Importantly, Novalis desired a table for possible fluid or chemical causes of disease, just as much as the already at hand Brunonian scale of excitability:

Es fehlen noch Gr[und]S[ätze] üb[er] die *Reitze* ... (*N*, 3, 377).

Part of Novalis's envisaged union of the two schools is, as Neubauer, points out, to link excitability theory with "a more exact account of the numerous factors in the environment and in the body itself" and to give "recognition to the dialectical interchangeability of opposites" (*337*, 111). One can add to Neubauer's analysis that a further part of the union envisaged by Novalis included Ritter's notion of galvanism and Novalis's own notion of method in his "Combinatorik" or phenomenal calculus. Thus, when Novalis speaks of the union of the humoral pathologists and neuro-pathologists in the following remark of 1798 he intimates his notion of phenomenal calculus in the term "Verhältnisformeln"; the term "Individuum" here refers both to the individual patient, and arguably, as later comments of Novalis's in 1799/1800 would seem to attest (see below), also to Ritter's notion of galvanic individuals:

Humoralpathologen sind nichts, als Dogmatiker - *objective* phil[osophische] Mediciner - Realisten. Die Andern sind Idealisten, *subj[ective]* phil[osophische] Mediciner.
(Erweiterter Begr[iff] v[on] Humoribus, erweiterter Begr[iff] von Nerven.)
Obj[ect] und Subj[ect] entstehn auch hier immer zugleich. In Brown soll eine Vereinigung schon seyn - und den besten Brownianern schwebt diese Idee auch dunkel vor - aber sie fallen immer in Einen der vorigen Irrthümer in ihren Ausdrücken und Anwendungen zurück indem sie die allg[emeinen] Gr[und]S[ätze] - specifisch und daher wieder eingeschränkt machen - da sie das Verfahren im Allg[emeinen] mit Buchstaben - nicht für jedes Individuum geltend annehmen, sondern a und b, wie specifische Classen ansehn, und nun den Vorrath v[on] Krank[heiten], Mitteln und Individuen dahinein vertheilen - indem sie nicht *wahrhaft relativ* - mit allg[emeinen] Verhältnißformeln verfahren (*N*, 3, 377-378).

Although Novalis felt the Brunonians were too systematic he did believe that the competent Brunonians were flexible and that they attempted to attain a union of the two schools of medicine.[11] However, Novalis also censures Brunonians here for lack of methodological breadth, and argues for more flexible use of their principles in a way akin to the employment of key phenomena in his notion of "phenomenal" calculus. In this way Novalis implies that the Brunonians should "experiment" more with their key principles and turn them into genuine "Verhältnisformeln" and pay more respect to the individual case. Out of the strict medical context of the time Novalis's envisaged union of the "Chemiker und Symptomatiker" (*N*, 3, 377) means something quite different from the actual contemporary humoral pathological and neuro-pathological viewpoints. Two concepts point to Novalis's real views: "Chemiker" and "Individuum". These terms can be understood in the light of Novalis's awareness of Ritter's physiological and electrochemical experiments, and the significance Ritter's work itself had for excitability theory. In Ritter's *Beweis* firstly the more complex notion of "Chemiker" is accounted for in affinity, electrochemistry and galvanism, and secondly, the notion of organization is given a particular galvanic meaning, as the individuals which form galvanic circuits. It goes without saying that the Brunonians and their major theorist, Schelling, pinned their ideas of excitability on the notion of purposive organization, but the type of direct links between the chemical and electrical phenomena of galvanism and excitability made by Novalis were not made by Schelling in 1798 (the time when Novalis referred to the need for a union of humoral pathologists and neuropathologists).[12] However, in 1799, in his *Einleitung zu dem Entwurf eines System der Naturphilosophie*, Schelling does indeed applaud Ritter's notion of galvanism, and points to the need for research into the links between galvanism and the life force of "Reproduktionskraft" (*109*, 323, 325 fn). In his *Erster Entwurf eines Systems der Naturphilosophie* Schelling links the chemistry of the organism to galvanism, and maintains that galvanism has far reaching consequences for the organic realm, for galvanism influences all its forces:

Man muß *a priori* behaupten, daß der Galvanismus, ebenso wie er die Sensibilität und Irritabilität afficirt, auch die Reproduktionskraft afficirt, daß also alle Secretionen, der Proceß der Assimilation - selbst die Bildung des Embryo - durch ein Gesetz des Galvanismus geschieht (*108*, 178 fn).

Schelling, then, like Ritter and Novalis, was proposing notions akin to bioelectrochemistry.

To deal with the first of the above factors of Ritter's galvanism, the chemical and electrical issues, it becomes clear in Novalis' writings that, in his view, the Brunonians did not only overlook the fact that fluids could be the cause of diseases, but also the notion that man, in a broader sense of the inorganic than fluids, was a galvanic entity and that there could be diseases due to lack of galvanic action:

Brown hat gar nicht auf die quant[itativen] und qual[itativen] Verhältnisse des Körpers gesehn - ihn nicht, als eine höchst zusammengesezte Maschine angesehn - deren Zustand durch äußerst mannichfaltige Ursachen modificirt wird.
Es kann Kr[ankheiten] aus Mangel oder Überfluß an Elektricität, an galv[anischer] Action etc. geben (*N*, 3, 602).

Novalis further suggested that the Brunonian notion of stimulants could be viewed in the light of the human electrical machine, since stimulants were forms of conductors:

Alle sog[enannte] *reitzende Substanzen* außer der Wärme sind *KraftLeiter* - also benehmend - die Lebenskraft erhält durch sie Spielraum.
Nährende Mittel sind *Halbleiter - Condensatoren.*
Nichtreitzende Mittel sind schlechte Leiter - *Isolatoren* - Kraftbeschränkende - *comprimirende - narcotische (in Ruhe setzende)* Mittel ... (*N*, 3, 477).

In this way, according to Novalis, galvanism, as an electrical and chemical phenomenon, could contribute to medical theory and practice.

Further, another remark of Novalis's refers particularly to some observations that Ritter makes in the final, speculative part of the *Beweis* which concern the role of chemical affinity in physiology within the galvanic organism:

Veränderung der Flüssigkeiten durch die *Gefäße* (*N*, 3, 603).

In the *Beweis* Ritter proposes a galvanic interpretation of the blood's circulation in the body, where the changing oxygen content of the blood (causing variations in the galvanic "action" due to chemical affinity), together with the muscles and the nerves, all form part of a circuit which ensues in muscle contraction and consequently the flow of blood:

Aber noch eins: wenn es etwan in der thierischen Maschine einen Körper gäbe, dessen Qualität in regelmäßigen Intervallen sich änderte; wenn dieser Körper Glied einer Kette wäre, deren Action zunächst gewisse Nerven leicht contrahirbarer Muskeln träfe, wenn etwa diese Muskelfasern zu Gefäßen gehörten, in denen Flüßigkeiten durch abwechselnde Verengerung und Erweiterung ihrer fortbewegt werden sollten, was würde denn wohl die Folge seyn von der durch die Undulation der Qualität jenes Körpers so regelmäßig bestimmten immer wiederkehrenden Veränderung der Action der großen Kette, zu der dieser Körper gehörte? Ohne Zweifel abwechselnde Verengerung und Erweiterung jener Gefäße. Und damit? Fortbewegung der in ihnen enthaltenen Flüßigkeiten. Giebt es aber in der thierischen Oekonomie wohl einen Körper, der obige Eigenschaften besitzt? O ja! das Blut. Beladen mit Sauerstoff (oxydirt) geht es in alle Theile des Körpers, giebt ihn da ab und kehrt, (desoxydirt) ebenso beladen mit theils von neuem Sauerstoff bindungsfähigen, theils dem Körper überflüßigen Stoff, nach den Lungen zurück, hier ändert es seine Qualität abermals um, um jenes Spiel von neuem zu beginnen (*R*, 165-166).

This is indeed a highly concrete picture of how chemical affinity, in Ritter's view, effects physiological phenomenon. Here Novalis's notion of pathologists as "Chemiker" can be understood as going considerably beyond the idea of chemistry that humoral pathologists stood for.

To deal with the second of the above factors of Ritter's galvanism, the "individuals" in galvanic circuits, it was not just in the way that man could be viewed as a galvanic "machine" that Novalis turned to galvanism in order to find solutions to pathology, for at another level Ritter's *Beweis* gave Novalis the material to see the body as a circuit within the giant galvanic circuit of organizing forces, where all the circuits belong to the purposeful whole of the Nature. Ritter himself describes how the minor circuits belong to the grand organized whole:

Von diesem *[the dynamic system of the body]* nun ist das einzelne Organ ein Theil, ein bestimmtes dynamisches Verhältniß, und drey dergleichen verschiedene sind es, welche wirksame Ketten geben. Aber jenes System ist selbst das was es ist, nicht durch sich allein, nur in sofern ist es dieß, als es Theil ist eines höheren dynamischen, des vollkommensten aber organischen System, *der Natur*, und daß es überhaupt ist, verdankt es selbst der Natur. *Sie* ist das Ideal aller organischen Wesen, absolut in sich beschlossen, ewig in sich, und ewig das was sie ist, bleibend, bleibend - *Natur* (*R*, 170-171).

Similarly, Novalis could remark, in respect to circuits of organizations:

Der K[örper] ist eine unendliche Kette von lauter *Individuen*.
*Alle Kr[äfte]* sind lauter LokalKr[äfte] (*N*, 3, 612).

Ritter's notion of organization substantiated Novalis's view that man is made up of organized processes at varying levels; and his notion of treating the patient as an "Individuum" implies viewing the patient as an organization with the potential to change through a "Combinatorik" of the organized processes. All the individual "LokalKräfte" and "Individuen" are to be harnessed to improve the patient's health as a whole "individual". All these forces and parts of the circuit are linked by the force of galvanism and it is through the use of this force that Novalis would seem to be speculating that patients should be treated. It may be that, in his "Verhältnißformeln"

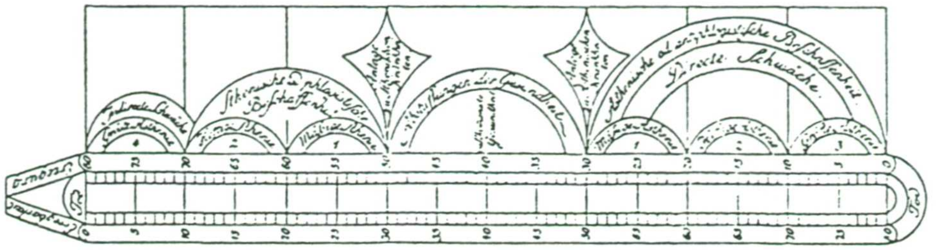


*Fig.6. Brown's disease chart in German.*

of organized processes, Novalis was thinking highly practically of a type of hand-scale or chart, such as Brown's (see above, *fig. 6)*.[13] Instead of Brown's states and the factors he attributes to excitability, and the mathematical, quantitative nature of Brown's scale, Novalis seems to be suggesting the ordered listing of the factors pertaining to the organized processes of matter, physiology, and the mind. A "Combinatorik" would reveal the relationships between these factors and their transitions, thus making it possible to view the patient in the broad terms of his whole "constitution".

Novalis's notion of the "Individuum" clearly spans the organic and inorganic realms, and his idea of the various "circuits" and levels of organization indeed finds in Ritter a strong source. In particular, in those experiments (depicted in *figures 67-71*) in the *Beweis* where the nerve plays so crucial a role in revealing an internal constant force, Novalis could have seen "proof" of the "individuality" or "personality" of natural phenomena. Moreover, even in the most basic galvanic circuits there was "individuality", for, in Novalis's eyes, in galvanic action and in chemical affinity, by means of a generative act, substances passed on their "personality" bound up in their material form, to another substance:

Die Af[finitaet] selbst dünkt mich - der Erzeugungstrieb der Individuen zu seyn. Der Process selbst - ein Generationsact (*N*, 3, 597).

Novalis here neatly translates the traditional notion of "Sympathie" into its modern correlatives in chemistry and biology respectively, with astonishing results, for he thereby links chemical with biological forces, and grounds the relational force uniting two "individuals" with the procreational force in a single "individual". His viewpoint avoids the tricky question of relating chemical to biological processes, not just by deriving one from the other, but by interpreting them both in terms of each other.[14] The resultant view of "affinity" is closer to Goethe's in *Die Wahlverwandtschaften* and elsewhere (*129*, 84-139) than to that of the chemists. However he goes beyond Goethe's view in envisaging a "circuit" - only distantly recalled in Goethe's references to Ritter's pendulum experiments (*129*, 180-187) -, which is based upon Ritter's idea of the vast organized galvanic circuit of Nature:

Man kann Reitz oder Thätigkeit durch bloße Veränderung der Kettenglieder hervorbringen. Alles ist Glied einer Kette. Jedes neue Glied veranlaßt *Repraesentationen* in den andern Gliedern - dadurch Thätigkeit ... (*N*, 3, 612).

Novalis's notion of the "individuality" or "personality" gives Ritter's concept of dynamic "individuals", "die Raumerfüllungs-Individuen" rather more eloquent form. The term "Repraesentationen" denotes a self-reflexive dimension in the process. The notion of "Repraesentationen" is reminiscent of another comment Novalis makes on the generative force in Nature, where he calls it "die innre *chiffrirende Kraft*" (*N*, 3, 627).[15] In activity bodies "draw" their forms (due to the internal creative force in phenomena), affecting other bodies, in an organized process; on a grand scale Nature is permanently generating "figures". The purposive virtue of "representation" was given, in Novalis's view, an empirical basis in Ritter's experiments, for through the mere change in the form of the galvanic circuits, galvanic action was caused ("Man kann Reitz oder Thätigkeit durch bloße Veränderung der Kettenglieder hervorbringen"). In another comment Novalis goes further to suggest that Ritter's notion of galvanism may indeed be the key to understanding the purposiveness of phenomena, since in the way it compounds and enhances the functions of phenomena, galvanism may be seen as the consciousness or soul of phenomena:

Wenn der Galv[anism] alle Functionen der individuellen Stoffe vermehrt, so ist er vielleicht nichts, als höheres Bewußts[eyn] - der Natur - Naturseele - Geist des Ganzen - politische Action der Naturkörper (*N*, 3, 603).

Ritter's physico-dynamic notion of organization is here elevated into a higher principle, which entails not just an animating spirit uniting nature, but a universal consciousness, too.[16]

*6. The role of the diagrams in the* Beweis*: diagrams as scientific tools.*

Ritter's discovery of the constant force of galvanism was not the product of some hypothesis. He was not attempting in hypothetico-deductive fashion to prove a theory: his discovery followed in essence an inductive type of procedure, based on a practical knowledge of the phenomena he was dealing with. A focal point for Ritter's methodological approach are the diagrams of the experiments, and it is the nerve which once again plays a crucial role here. Novalis was highly aware of the significance of the diagrams and interpreted them in the light of his own notions of method and inquiry into knowledge (see below, sections 7, 9 and 10). Before discussing the diagrams in Novalis's terminology as natural philosophical productivity, I wish first to contextualize the diagrams in the light of current views in the history of science.

Present historians of science such as Gooding, Nickles and Pickering argue for inductive types of inquiry procedures based strongly on the issues concerning scientific practice itself. The issues they raise are highly relevant to Ritter's own method. Highly relevant too for natural philosophical productivity, as shown in the introduction, is Toulmin's discussion of practical knowledge. As mentioned, Nickles argues for generative induction and "know-how". In Nickles's view we come to theories by building on what we already know, and he contrasts this notion of inquiry with the hypothetico-deductivists' "knowing-that". He remarks how the seventeenth century "hypotheticalists" or "consequentialists" "held that empirical support results from successfully testing the predictive consequences of theories, no matter how these theories were obtained" (*248*, 304). He further comments that the hypotheticalists' method in effect "means that all scientific justification reduces to a claim's record of predictive success" (*248*, 304). In contrast, the inductivists stress practice and not theory. Of course an argument against inductive procedures is the very subjectivity of "know-how" and human skills; for many scientists "know-how" does not count as objective knowledge. The editors of *The uses of experiment* (*177*) point out that the discovery processes themselves are mostly left out in reconstructions of experimental and theoretical work, primarily because of a prejudiced stance:

Traditionally, philosophers have divorced the unruliness of discovery and discovery arguments from the logicality of justification (*177*, 12).

Concerning Gooding's views, the editors further point out the hypothetico-deductivist epistemological use of experiment actually obfuscates the distinction between phenomena and theory. For if the scientist is always using experiment to defend theoretical claims about nature, in effect, the process of inquiry is reduced to theory alone, and the scientist is only in touch with theory and not nature. The actual cognitive role of experiment, whereby meaning is found in discovery processes themselves, and whereby nature herself is questioned, is discarded, and in its place theory stands, isolated from the phenomena:

But if phenomena are always elicited and rendered, then the distinction between observation and experiment begins to blur. With it go the reassuring notions that scientists produce natural phenomena and laws *and* that they can claim that their representations of those facts correspond to the way things really are (*177*, 14).

Moreover, the editors remark how the issues arising out of scientific practice are in general permanently of value for the sciences since debate is always kept open by new discoveries:

Traditional philosophical methodologies assume that knowing *how* to produce a phenomenon or datum is irrelevant to showing *that* it the case. All that matters is the theoretical interpretation of phenomena and data. However, if "closed" debates are always liable to be reopened on all fronts (for example, by new empirical and theoretical results and instrumental possibilities), then the "how" never ceases to be important. The competences which enable generative forms of justification are never as far away as consequentialist philosophies assume (*177*, 13).

In Ritter's method inductive procedures, experimental skills, the cognitive role of experimentation, "know-how", and the process of discovery itself, all play a crucial role. Moreover, his open method accords very much with the point made above on the importance of scientific practice in general for theory, since in the construction of his theory of galvanism it is "know-how" which essentially steers his inquiry, and Ritter is conscious of the importance of issues of practice for theory. Ritter's inquiry bears many of the characteristics of Toulmin's idea of practical knowledge. Ritter's know-how can be seen as something akin to "phronesis" since aesthetic and moral elements are intimately bound up in his form of natural philosophical productivity. Further, in the light of Toulmin's thought, as already discussed, there are links between the interdisciplinary approach to knowledge found in case studies and Ritter's approach to inquiry. Indeed, Ritter's work underlines the epistemological value of the case study, for he did attain significant results by concentrating a variety of theoretical viewpoints around the case of galvanism, and, in particular, around the phenomenon of the nerve.

A general discussion of the implications of Ritter's diagrams is necessary before specifically treating the role of the nerve. The seventy-eight diagrams in the *Beweis* which are used to illustrate the galvanic experiments are consciously used by Ritter for theory building. The use of tools or instruments whether they be apparatus or diagrams is often taken for granted by scientists, as has been made apparent above in the general neglect of the issues of scientific practice by practitioners themselves. Ritter sees his diagrams as "Figuren" or "Formeln", understanding them as instruments to assist inquiry. Since he views diagrams as a form of apparatus assisting inquiry, the diagrams themselves play a different role in his method than would conventional mimetic diagrams, which do no more than mirror the phenomena under investigation. Conventional mimetic (or "corporeal") diagrams are referential; Ritter's diagrams on the other hand are abstractions or schemes of the empirical world, which are to be treated not as referential but as representative. Conventional diagrams assume no difficulty in the translation of phenomena; Ritter's diagrams show his awareness of this difficulty. They are a specific reading of Nature, justified by the notion that a subjective element is always present in man's analysis of nature, in other words, looking at nature involves man's skills, and consequently models of nature are never absolutely objective but are necessarily intertwined with man's subjectivity. In the introduction to the *Beweis* Ritter refers to the importance for him of self-conscious theorizing and the need for the scientist to be acutely aware of his own subjective contribution to inquiry:

Wachsamkeit über seine Thätigkeit muß also das erste Erforderniß des Naturforschers ... seyn (*R*, x).

It is in the way that the diagrams are a product of man's agency and subjectivity that the diagrams in the *Beweis* are non-referential. They are presented as a particular interpretation of Nature; and as an embodiment of man's skills they are, further, "phenomena" in their own right. They are, then, both a form of visual argument, and the subject of that argument. Their character might best be defined as symbolic. This is a rhetoric of experiment that emphasizes the epistemological nature of aesthetic productivity and the idea that the imagination plays a key role in cognitive gain. The diagrams can, further, be viewed as scientific models. The diagrams are conceptual models and theoretical tools. However, Ritter's or Novalis's notion of the diagrams (see below, sections 6 and 8) cannot, for instance, be equated with a view of modelling such as Pickering proposes. Pickering is a realist in tendency, and his notion of a "phenomenal model" is too formal and conceptual to be compared with Ritter's diagrams. Pickering clearly states that his "phenomenal model" is "a conceptual understanding of whatever aspect of the phenomenal world is under investigation" (*254*, 277). Although it can be said that Pickering's notion of a "phenomenal model" does come close to the way Ritter's diagrams function, since Pickering sees his "phenomenal model" endowing "experimental findings with meaning and significance" (*254*, 277). This is important because Pickering implies here that knowledge of nature necessarily entails a mediation between the scientist and the phenomena under observation. However, the notion of a scientific model espoused in Ritter's diagrams is best expressed by Gooding's notion of models, and, indeed, highly appropriately by his account of Faraday's development of field theory. Gooding argues for the importance of non-verbal forms of knowledge in discovery processes and shows how Faraday did not have a "verbally articulated expression" of his field theory until the 1840's (*176*, 219); up to then Faraday had been expressing his theory non-verbally, in what Gooding calls "instrumentally useful concepts" (*176*, 192). Gooding's notion of a scientific model comes very close to Ritter's concrete diagrams, and, naturally, the way Faraday used his diagrams of field theory, as part of a discovery process before formal verbal theory was attained, is paradigmatic of the way Ritter, from the very start of his *Beweis*, employs his diagrams of galvanic processes as instruments for the construction of his theory. Gooding's argument that Faraday was using "instrumentally useful concepts" in the non-verbal expression of his theory also underlines how important representation is to discovery in the context of forms of public demonstration which interact with laboratory work, and Ritter, in this sense as well, binds representation into his demonstration and discovery process from the start.

There are, moreover, several aspects to the way Ritter employs the diagrams as representations of, and as heuristic tools to obtain, knowledge. In Ritter's work the diagrams often are used literally as formulas ("Formeln") in the conventional meaning where the values can be exchanged and different results obtained. The notion of a formula points to the endless variability of the phenomena operating within a certain scheme and assists the scientist in exploring behind the phenomena to the internal causes. This process is generally hindered by mimetic diagrams since the figures have an absolute realistic value. Ritter for example uses his *figure 11* many times as a fundamental galvanic scheme operating with different values. Amongst the subjects he discusses with it are the role of oxygen affinity (*R*, 59) and the galvanic experiments on the eyes (*R*, 90).

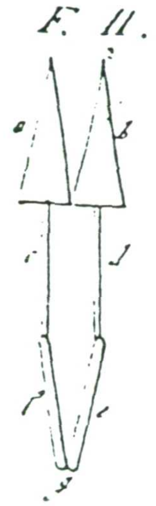


*Fig. 7. Ritter's galvanic diagrams, figure 11 as a "formula" (Beweis, 1798).*

The further aspect of the diagrams' formularistic character is the way Ritter uses them to break down compound or muddled phenomena into their component parts. In this way, the diagrams can be seen not only as literal formulas and as a clear concrete analysis of phenomena in galvanic schemes, but in addition, in a further analytical sense, they are employed to break down and represent complex phenomena in the experiments. Thus *figure 40* is analyzed into its component parts depicted in *figure 41a* and *figure 41b* (*R*, 60). *Figures 41a* and *b* split up *figure 40* into its circuits and demonstrate more clearly in which direction the galvanic force is flowing. The diagrams act here as useful tools to the scientist as representative and analytic formulas.

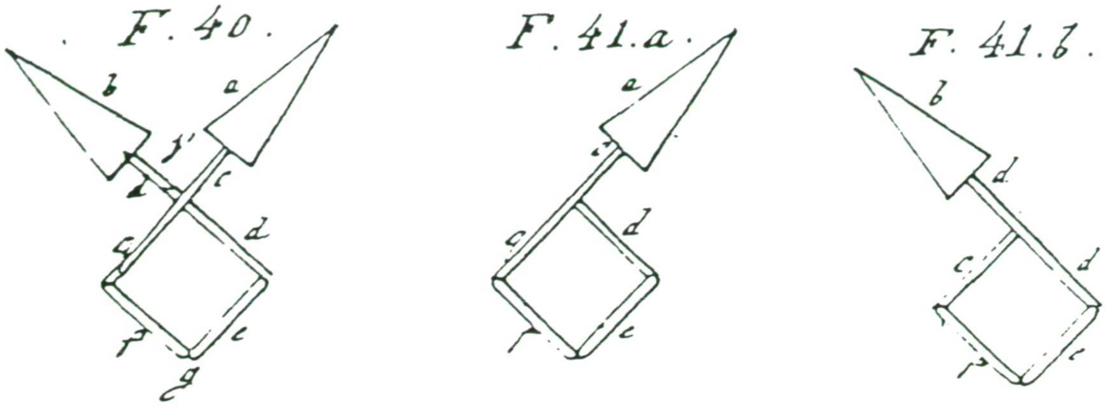



*Fig.8. Ritter's galvanic diagrams, figures 40, 41a and 41b as "formulas" (Beweis, 1798).*

Most important, however, is that all the diagrams form part of a practical demonstration of Ritter's notion of galvanism. Before Ritter set out on his 'proof' and the experiments presented in the *Beweis*, he had a notion of a dynamic force in Nature, but did not have the necessary concepts or evidence to substantiate his view of such a force. In the process of the "proof" the diagrams are developed and used as a non-verbal form of theory; they are one (extremely important) step towards the construction of a formal theory. The first step is Ritter's particular arrangement of the materials and phenomena in the individual experiments as expressed in his diagrams: from the very start of his "proof" he explains his theory, through the diagrams, in terms of the positions of the various conductors in the circuits. In this way Ritter attempts to read Nature in her own language. Although the diagrams are a reflection of the phenomena they are, as mentioned, as a product of interpretive skills, "phenomena" in their own right, and in a further sense "phenomenal", since Ritter uses them, precisely as reflection of phenomena, to be ever in close contact with the phenomena. The diagrams are themselves a reflection of what is in fact a highly inductive approach, since it is one which remains as close to the phenomena under investigation as physically possible. One can then speak of a progressive method, leading from actual physical phenomena in the experiments to the semi-abstract or symbolic diagrams, and concluding with the ultimate, "abstract" expression of theory in his notion of a constant force.

There is no doubt that Ritter uses the diagrams to give visual expression to his theory, they are the closest tools he has to the phenomena and give his theory form in "visual argument" by mediating between abstract theory and the actual experiments themselves. In this manner, the diagrams could be said to constitute a "phenomenal theory". In their deployment as a process of visual argument they provide the means of attaining and expressing his own final "abstract" verbal argument. That the diagrams are part of the practical demonstration of theory is particularly evident in *figures 64* to *76* (*R*, 107-154) where Ritter discusses his theory almost purely in terms of the diagrams. Indeed, on reading the *Beweis* one often has the impression that theory is literally left in the diagrams. In *figures 64* to *76* Ritter lets the phenomena undergo many "modifications": these alterations to the circuits are the non-verbal twists and turns in the practical demonstration of his theory.

Ritter's emphasis on the modifications to the circuits also underpins his sophisticated awareness of induction. His desire to be faithful to Nature does not imply that he discards theory. The notion of "Modifikationen" implies that induction necessarily involves a process of multiplication, exclusion and selection. Pure induction is a fallacy to Ritter since his process of induction includes theorizing with the phenomena under investigation. The "crucial" experiments in *figures 67 to 71* are not cases of "pure" induction or, to express it otherwise, of "deducing directly from the phenomena", although their particular clarity of proof in their phenomenal rhetoric would suggest this. These experiments only have a special status when understood in the light of previous modifications. Modification (implied here is "multiplication" or "variation"), exclusion and selection, viewed as a general process of theorizing with the phenomena, are the necessary fundamental activities for anything which resembles "pure" induction. In this sense induction and practical demonstration are indeed the key to the methodology of the early Ritter.

Conventional mimetic diagrams such as Humboldt's are not part of the same demonstrative method, nor are Volta's diagrams, although they are not mimetic, but representative, like Ritter's diagrams. Volta's diagrams are not however part of an active process of theory building. They reflect instead a hypothetico-deductive approach to scientific inquiry. Volta's diagrams merely represent his already verbalized theory.

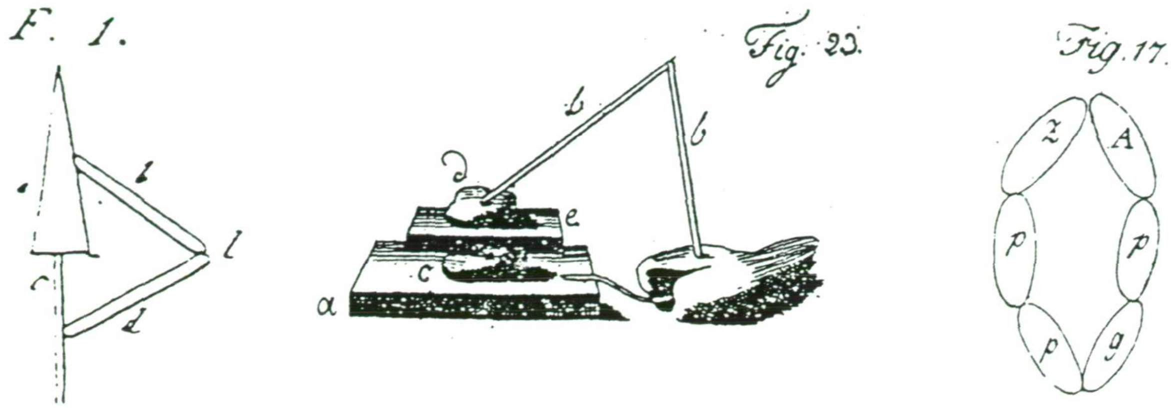



*Fig.9. Galvanic diagrams, from left to right, Ritter (Beweis, 1798), Humboldt (in 54, 1797) and Volta (in 121, 1797).*

Ritter's diagrams, then, become tools and part of a method where the scientist can look to them for support, as representational models, and thereby as a consistent "phenomenal" structure upon which he can develop his theories. In general the diagrams are symptomatic of a practical non-verbal form of scientific inquiry. For Ritter, the scientist must be capable of working with non-verbal forms of theory: to this end experience is essential. The experienced experimenter working in a new area stands beyond conventional theory and before asserting a new theory he must be well versed in non-verbal forms of theory. In terms of tacit knowledge one can say that Ritter is insinuating a form of "expert" knowledge. In the light of Toulmin's thought Ritter is here relying upon "phronesis". The experimenter has to have a feel for the practice of the laboratory and be able to see theory active in the phenomena. Ritter explicitly suggests this when he introduces *figure 73* as a case, in his view, for the experienced galvanist:

Noch will ich einige erfahrneren Experimentatoren vielleicht nicht unangenehme Modificationen jener Versuche beschreiben ... (*R*, 117).

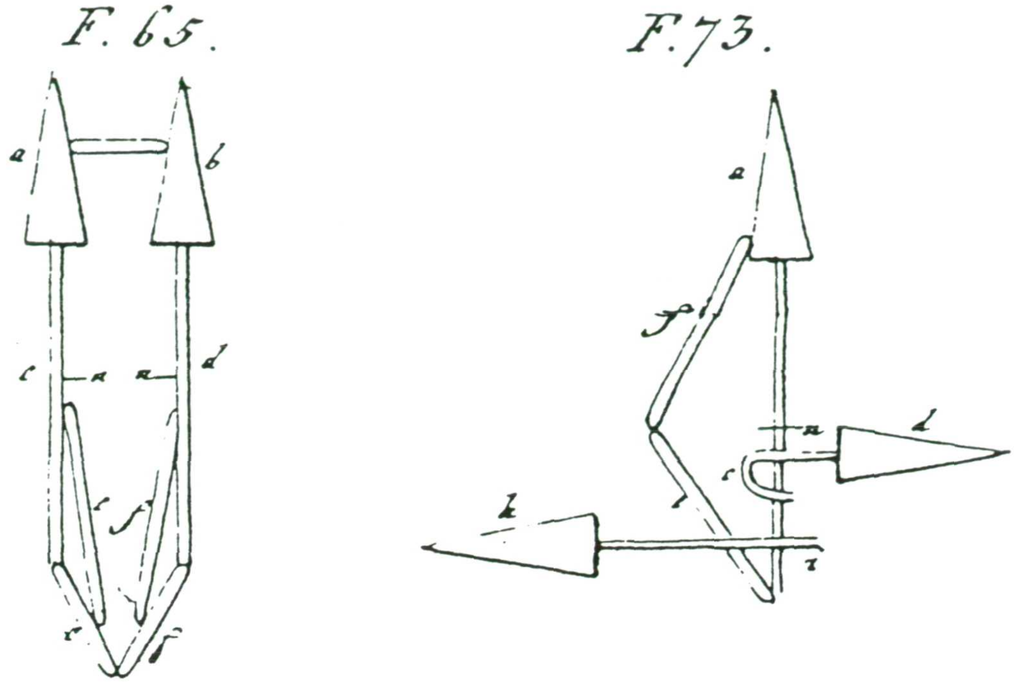



*Fig.10. Ritter's diagrams, figures 65 and 73, "Noch will ich einige erfahrneren Experimentatoren [...] Modificationen [...] beschreiben" (Beweis, 1798).*

*Figures 65* and *73* are cases where the experimenter must have gone into the area of phenomenal debate. (*Figure 73* is another example showing up the deficiencies of Volta's theory of contact electricity). Ritter introduces the complications of *figure 73* because the modification above the cut nerve in *figure 65* (*R*, 117) causes no "action"; in *figure 73*, Ritter gives an example of a case where "action" is still shown above the cut in the nerve by introducing the pairs of nerves and muscles *cd* and *hi*. *Figure 73* presupposes an experimenter with a fine touch, who is aware of the practical difficulties and subtleties. In this experiment Ritter is modifying the "action" in the basic circuit of *aef* (*R*, 117-118). "Action" in *a* has been reduced because the nerve has been cut at *n*, but Ritter shows here that although *a* does not contract there is a certain amount of constant "action" in this closed circuit. Ritter shows in *figure 73* that there is a relative constant "action" in the primary circuit *aef* : the "action" in the muscles *h* and *d*, when added to the primary circuit, is not due to the fact that they have brought a new effect ("Wirkung") to the circuit. Instead, the contraction of *h* and *d* are due to the already constant "action" in the primary circuit *aef*. If the added muscles and nerves *hi* and *cd* had brought some new effect to the circuit, then *a* should have contracted, but it does not. If *a* had contracted then galvanism could be seen as a contact phenomenon. For Ritter, the introduction of the new pairs of muscles and nerves *cd* and *hi* modify the circuit and cause a change in the inner dynamic process. In this light *figure 73* presupposes an experimenter who has considerable experience of galvanic activity: it implies a general knowledge of cutting the nerves and, consequently, of the modifications of changes of direction of galvanic "action" through the nerve, and knowledge of the alteration of the nerve's form as depicted in *c*. It implies also knowledge of complex combinations of conductors and ways of forming circuits. In *figure 73* Ritter is not merely adding metals or organic conductors to the circuit, but, instead, with a fine touch, stressing the interplay of organic and inorganic conductors, and, in particular, observing complex alterations to the organic conductors.

In this demonstration of practical knowledge, *figure 73* indeed exemplifies how the experimenter in Ritter's view theorizes directly with phenomena; he constructs theory directly out of Nature. Here demonstration and experience, non-verbal forms of knowledge and "know-how", are interlaced, and in this way man uses Nature herself in his own models of phenomena as a tool to support theory, in what is an inductive form of inquiry, employing "phenomenal" theory. The next section will treat Ritter's work in terms of Novalis's notions of natural philosophical productivity.

*7. The aesthetics of natural philosophical productivity. Novalis's interpretation of Ritter's diagrams: "die Instrumentalsprache".*

Novalis's important notion of an "Instrumentalsprache" (*N*, 3, 91) is a direct response to the way Ritter uses the diagrams. The "Instrumentalsprache" implies that "instruments" are part of and are reflecting the phenomenal non-verbal debate. "Sprache" suggests a form of language and communication, and "Instrumental-sprache" suggests an argument formed by the positions and activity of experimental apparatus. Novalis's views on scientific method very much cohere with Ritter's practice. As indicated, in his scientific method Novalis is not a hypothetico-deductivist, he does not believe in formal theory alone; his notion of an "Instrumentalsprache" - which involves the employment of symbols of the imagination - usefully illustrates and elucidates his view on the role of aesthetics in practical knowledge. The term "Instrumentalsprache" further indicates how he views scientific practice and theory as a whole, with the scientist, the apparatus and Nature all playing a role. They all form part of an experiential whole, reasserting Novalis's understanding of knowledge in his notion "Experimentalphilosophie". For Novalis, as is also implicit in Ritter's method, what the scientist contributes in practice is seen as a "phenomenon" in its own right. Man's thoughts alone or as exhibited in the apparatus and diagrams are just as much a part of Nature as the rest of the observable phenomena:

Instrumente und Apparate sind *reale* indirecte *Formeln. Maschinen sind Formeln.* (Ritters Figuren) Das Resultat einer vollständigen wissenschaftlichen Universalmaschine würde eine Natur, oder ein Chaos seyn.

Algebr[aische] grammatische Bearbeitung der Instrumentenlehre. Electrischer generalisirter Apparat, nach Ritters galvanischen Apparat auf dem Papier.
Über die Kupertafeln an mathematischen Büchern ... Ansicht eines Experiments in einer *steigenden* Reihe von Gesichtspuncten.
*Übersetzung in die Instrumentalsprache* (*N*, 3, 91).

The diagrams for Novalis are "real" because they are phenomenal, they are man's "natural" thoughts. The diagrams are "indirect" because they are representations of natural phenomena. That they are representations does not prevent them,in his view, from being phenomena: they are a part of man's experience and skill. The diagrams are a type of language and a certain transliteration of Nature. The language of instruments in Ritter's case has tapped into Nature's galvanic language, and, as Novalis suggests, if this language were completed, a new "Nature" would be produced in the sense of a whole or a complex dynamic chaos. The language of instruments, in its inventiveness and through its "Sympathie" with the phenomena of Nature, has the potential to create a model of Nature, or as an experimental, practice-oriented form of theory it mirrors the very creativity of Nature herself, and her own experimental potential for creating out of chaos. For, as implicit in the driving forces of "Lust und Unlust" (*N*, 3, 423), Novalis's idea of Nature takes account of her changing form: in his view, Nature is continually "experimenting" and creating new forms operating on the generative force of "Sympathie". In his threefold view of the history and eschatological progression Nature was in the second phase of "Chaos", and moving potentially towards the second Golden Age.[17] Thus the notion that man can produce a formularistic translation of nature in a language of instruments introduces an additional epistemological layer to Novalis's utopian notions. It illuminates how man has an intimate bond with nature, and that man's subjectivity embodied in his skills is part of inquiry, and this type of inquiry is on the path to the state of the free "plasticizing" of the imagination.

Novalis makes his views clear on the phenomenality of language itself in his piece *Monolog* (*N*, 2, 672-673). Here he refers not to a conventional formal language but to a living language. His view of language does not imply that language is meaningless, relative or non-referential in a semiotic sense; what it does imply is that language is an entity and that it attains meaning only in practice and not in formal discursive use. This sense of language as an active reading of Nature or form of non-verbal argument (where "verbal" here refers to language in the conventional sense) is precisely what Novalis sees realized in Ritter's diagrams. The diagrams are an important example of some hope of returning to the subject in the broader sense of practical knowledge in inquiry.

The direct reference to Ritter's diagrams in the remark above reveals both what Novalis saw in his galvanic diagrams and the further potential Novalis saw in general for inquiry in such practice-oriented modes of discovery. Novalis's notion of an "Experimentencalcul" is borne out in Ritter's diagrams:

Algebr[aische] grammatische Bearbeitung der Instrumentenlehre. Electrischer generalisirter Apparat, nach Ritters galvanischen Apparat auf dem Papier (*N*, 3, 91).

The formularistic ("Algebr[aische]"), "grammatical" development of the language of instruments is a method of speeding up the processes of discovery. Furthermore, as Novalis comments, he saw in Ritter's diagrams of his experiments potential for composing and designing a general apparatus for displaying electrical phenomena. An inventive calculus based on Ritter's galvanic "formulas" of electrochemical and physiological phenomena meant, in Novalis's view, that the formularistic diagrams could be used to develop a technological apparatus. He was thus suggesting the enormous potential technical implications of Ritter's galvanic experiments. Here Novalis is proposing a highly practical use of a general calculus. In addition, the reference to mathematical diagrams further substantiates that in Ritter's diagrams Novalis saw a potent form of knowledge. To Novalis, Ritter's diagrams display a power related to the *a priori* perfection of mathematics, in that they provide a coherent basis for "algebraical grammatical treatment". Without being mathematical themselves, they exhibit, in Novalis's view, the same kind of order and coherence, and Ritter's diagrams do indeed argue cohesively for a new and better understanding of galvanism. The language and argument of the diagrams are as concrete as mathematical diagrams, and a "natural" algebra of galvanism. Thus, in Novalis's view, the language of instruments is an area of knowledge where the concrete notions of the subject are put into their rightful place as a necessary prerequisite for inquiry.

Moreover, Novalis's "Instrumentalsprache" importantly emphasizes the actual process of discovery itself, and his highly practice-oriented notion of "Experimentencalcul". For in the combination and variation of experiments in his process of "Experimentencalcul" it is the language of instruments that enables various theoretical viewpoints to be realized and to be employed as concrete practical knowledge, and thus he is led to remark:

Ansicht eines Experiments in einer *steigenden* Reihe von Gesichtspuncten.
*Übersetzung in die Instrumentalsprache* (N, 3, 91).

The language of instruments illuminates how Novalis envisaged an aesthetic and progressive inductive procedure wherein a mediation between theory and phenomena occurs in the form of concretizations of the observed phenomena. The experimenter closes in on the subject of investigation using the tool of instrumental language "in einer *steigenden* Reihe von Gesichtspuncten", and here Novalis implies that it is the language of instruments that is paramount, in the process of discovery, in enabling the scientist to make representations of natural phenomena and laws. It is suggested that through a concrete language of instruments the scientist comes increasingly ("steigend") closer to the position where he can say that his theory, i.e. his representation of nature, actually reflects Nature herself. The language of instruments, crucially, as a concrete form of knowledge, remains as close to the phenomena as possible, and also, as part of a discovery process, comes nearer to a proper explanation of phenomena. This sense of "die Instrumentalsprache" gives Novalis's practice-oriented notion of knowledge and inquiry a base of considerable significance. Here the rhetoric of experiment highlights the epistemological value of aesthetics in discovery processes. The rhetoric also illustrates how aesthetics are not used in the sense of fiction, but instead as experiential knowledge. In the language of instruments, phenomena are re-experienced in a form of symbolic knowledge that mediates between theory and phenomena. Cognitive gain through the use of aesthetics is shown here in the experiential nature of such symbols and their employment in a progressive form of inquiry. The instrumental language serves to display just how important the issues of experimental practice are for theory, and how in Novalis's view, the sciences should pay attention to the working method of the inquirer himself. In 1800 Novalis remarks, in the same spirit, how significant the practical and technical aspects of inquiry are:

> Allgemeine Behauptungen gelten in der Naturlehre nicht. Ihr Vortrag muß *practisch, technisch, real* seyn - Schritt vor Schritt entwickelnd - construirend, wie die Beschreibung einer technischen Arbeit (*N*, 3, 600).

When Novalis is speaking of a language of instruments or of a form of "phenomenal calculus" it is clear that he is always referring to the process of knowledge itself and not the final theoretical statements of a theory. He suggests that progress in the sciences emerges out of close adherence to practical procedures; "general claims", i.e. theoretical statements on nature or systems of nature do not, in his view, assist progression. It is, instead, detailed ("*technisch, real*") procedures which remain close to the phenomena, such as are carried out in Ritter's diagrams, which have direct practical relevance and are part of a practice-oriented procedure, which best serve in constructing theories. The language of instruments, as part of a discovery process, and as the fundament of a concrete, "phenomenal" calculus, is thus a major notion in Novalis's view of scientific inquiry, and a major concept in his notion of knowledge in general, since he essentially demands such a practical and concrete form of thought in all areas of knowledge. Progression and discovery in all spheres of man's activities are, for Novalis, governed by a particular closeness to experience itself; knowledge is itself an instrument of experience, and always has to be "experimental", i.e. experienced. Thus, the language of instruments offers a particularly coherent picture of the manner in which aesthetics are employed in inquiry and shows that aesthetics are a keystone of Novalis's stance to natural philosophical productivity.

*8. The role of the nerve in Ritter's aesthetics of natural philosophical productivity: the individual's methodology and theory.*

Up to this point the diagrams have been viewed as part of a general non-verbal attitude to the investigation of nature and in terms of the aesthetics of natural philosophical productivity. However, the diagrams, through their depiction of the nerve, also illustrate the link between the individual inquirer's theory and the realization of his methodology in the diagrams themselves. The depiction of the nerve itself illumines its status and particular nature in Ritter's theory of galvanism; the depiction emphasizes that the nerve symbolizes Ritter's notion of matter, and, also, his method of inquiry itself. Here we can see the emergence of the notion of unifying practice, which will be developed in the following sections. The unification lies in linking concrete, practical forms of theory (the symbolic role of the nerve for galvanic theory) with the realization of the inquirer's methodology in the diagrams. This means that a careful analysis of the diagrams is now called for.

What differentiates Ritter's diagrams from Humboldt's conventional mimetic diagrams and Volta's representational ones is indeed above all his use and representation of the nerve. Ritter's diagrams in a sense hover in between the mimetic (direct depiction of an object) and representational (non-referential, standing in for an object), for whereas the conductors in his figures can be seen as abstract, relative and interchangeable, the depiction of the nerve and muscle can not: the lines standing for the nerve and muscle may be abstract but they are the one constant phenomenon depicted in the diagrams. In other words, they are the constant factors in these visual formulas. Since the nerve and the muscle are constant factors in these otherwise abstract diagrams they are singled out from the other parts of the "formulas" depicted: they can be seen as the most concrete among the abstract figures. Further, if one looks at the diagrams as representations, the nerve and the muscle, because of their relative concreteness, form the link between the inner forces, i.e. the less visual, more abstract phenomena, and physical matter. If one looks at the figure of the nerve and the muscle mimetically it provides a link between matter and the inner forces because of its relative abstractness. Moreover, if scientific diagrams or apparatus are models of Nature, it is the figure of the *nerve* itself, because of its importance for galvanic laws, which out of all the galvanic apparatus best represents Nature. The *figure* of the nerve can be understood as a concrete "natural" model, in one sense of this term, reflecting the bond between man and Nature in the visible, concrete theory of the diagrams. (At another level, our concrete *perception* of the phenomenon of the nerve itself, external to the diagrams, when the nerve is perceived in terms of theory, is a concrete "natural" model, from which one can directly read off the theory, since the nerve is exemplary of important general laws of Nature.) As a concrete sign the figure of the nerve is symbolic: symbolic, as mentioned (see above, section 4), in the particular manner that the nerve is understood as matter with its own inner dynamics which form part of the constant force of galvanism in the whole of nature. Further, in Ritter's galvanic diagrams the straight lines of the nerve going into the triangle of the muscle complete the symbolic arrow, which symbolizes Ritter's new galvanic law that the current flows from the nerve into the muscle. Thus the figure of the nerve symbolizes both the constant force in the organic and inorganic realms and the fact that the force has a direction within a closed circuit. The figure of the nerve is, additionally, "symbolic" of Ritter's method in general; just as the figure of the nerve links phenomena to concrete theory, so does his method in all its aspects. He closes in on the mysterious phenomenon of constant galvanism, critically and gradually modifying the phenomena, always supplying the theory with a concrete representation in his diagrams.

The nerve is, on this interpretation, not an absolute abstract figure; as a 'natural' model it is a concrete sign: it is a point where theory and Nature meet, or to state it otherwise, it is where human skills extend into Nature. Man's agency is here so in tune with Nature that it can be seen as actually entering into its secrets. Ritter's specific depiction of the nerve (as the straight lines of the symbolic arrow), which is neither entirely abstract nor entirely mimetic, is opposed to the invisibility or "abstractness" of Volta's physical force and the visibility or "mimetics" of Humboldt's idea of a vital substance. The concrete depiction of the nerve "visibly" symbolizes important galvanic laws occurring internally within phenomena, and, as the one "constant", concrete figure, as the one recurring symbol in the diagrams, it further reflects Ritter's notion of galvanism, which is a constant force and an internal force, inwardly active yet "visible" throughout nature. One can here perhaps talk of "natural" signs to bring out the notion that, in Ritter's case, the inquirer's skills act as a medium of natural laws; they are "natural" because they are an attempt to imitate natural phenomena. In this imitation they pay respect to nature by staying as close to the phenomena as possible. "Natural" also refers to the way such signs, in the type of theory they reflect, also pay respect to purposiveness in nature. These are key aims of the unification of practice, to seek out a theory which reflects purposiveness in nature, and to arrive at a form of knowing in dealing with nature that is itself as "natural" as possible, i.e. reflecting the way knowledge is part of a greater experiential whole. The experiential and "natural" form of Ritter's methodology, as manifested in his diagrams, would attest to this.

The figure of the nerve reflects Ritter's wish to unite a more abstract understanding of matter with a concrete perception of its inner forces. The abstractness of Volta's conventional representations reflect his interest in the inner force of contact electricity. The lack of any constant visual factor or permanent concrete reference in his diagrams betrays his static model of nature. Contact electricity is not a constant phenomenon and consequently there are no constant factors in his diagrams. Contact electricity is a polar phenomenon revealed in the static, mechanical nature of his representations. Humboldt, on the other hand, has a vital materialist approach: the importance of substances is reflected in his diagrams, they offer a materialist mimetics of natural phenomena. His diagrams stay, as it were, on the surface of nature, stressing external factors. In his belief in the "Nervenfluidum" Humboldt does not "abstract" from the "exciting" substance to a wider notion of a universal physical and organized force. Humboldt's insistence on the substance of the "exciting" "Nervenfluidum" and his belief in the "absolute" (as opposed to relative) effects of the conductors on galvanic action prevents him from looking inside nature:

Es scheint mir nemlich, als sey das circulirende unbekannte Fluidum zwar allerdings schon in jedem Theile der Galvanischen Kette excitirend, als äußere sich aber dieser excitirende Kraft, auch bei gleicher Reizempfänglichkeit der Organe, in ungleich höherem Grade bei denen, welche unmittelbar armirt sind, als bei denen, welche von den Armaturen entfernter liegen (*54*, 1, 202).

Humboldt is here referring to local effects of galvanism caused by both the conductors themselves and the nerve fluid. Humboldt suggests that the force of the nerve fluid "expresses" itself to a greater extent in those parts of the circuit which are closest to the poles or points of contact itself. This could be termed a vital materialist's answer to contact electricity, which in a tautological fashion, concentrates only on the external in the experiments. Ritter's method goes on to explain galvanism further, looking behind the external appearances of effects at the points of contact to the internal process throughout the active circuit, and searches for an "abstracter", i.e. internally active, but none the less visible (in Nature's activities), universal physical and organized force. Ritter's *figure 72* (*R*, 115-116) (see below) shows for example that there may be apparent local effects but these are due to inner forces at work in a closed circuit and the effect of the nerve on the direction of galvanic current. *Figure 72* demonstrates how adding a conductor only causes contractions in the muscles when it affects those parts of the circuit determining the *direction* of the current ("... nur in dem der Wirkung der Kette unmittelbar ausgesetzten Theile ..."). The addition of the conductors *o* and *t* has no effect, but *n*, *m* and *p* do cause contractions because they are affecting the primary closed circuit ("Grundkette") *fαe*. As further "proof" Ritter introduces *s* to the apparatus which forms a new closed circuit and thus causes the muscles to contract.

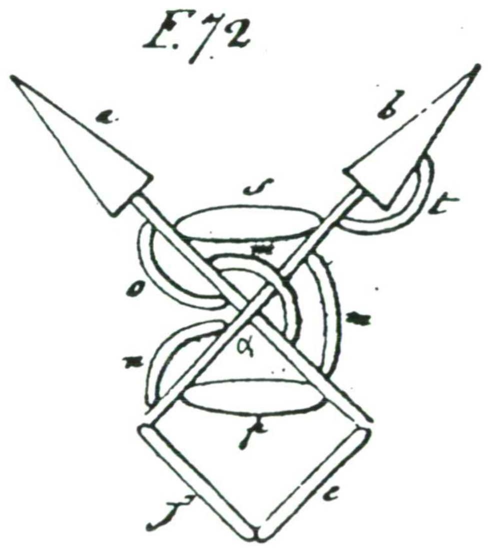



*Fig.11. Ritter's galvanic diagrams, figure 72. The symbolism of the nerve. (Beweis 1798).*

All the conductors added to the initial components in the experiment in *figure 72* only cause action by altering the structure of the circuit. The "external" conductors themselves are relative to the whole inner dynamic process of the closed circuit. The implicit role of the nerve's symbolic straight lines completing the arrow as a permanently recurring symbol is important: it highlights the principle of galvanic action, the constant, "permanent" flow of the current in a particular direction in closed circuits. The nerve is therefore a "symbolic" determinant of the direction of the galvanic process and points to the fundamental internal dynamic process of galvanism: externally the nerve appears to undergo no changes, but because of the effect it has on circuits there clearly is electrochemical activity occurring within it.

It can be said that what Humboldt does in his diagrams is to "externalize" his inner material laws. This could be said to make his diagrams tautological. Humboldt's notion of the inner laws of galvanism is material (the nerve fluid), and it is not surprising therefore to see no hint in his diagrams of an inner force process. His materialistic outlook is reflected in the way he unproblematically depicts Nature in the diagrams. Both Volta and Humboldt have a formal way of reading Nature. In their work under discussion here, neither of them shows an awareness of the notion of concrete theorizing in their use of diagrams: human skills appear to be taken for granted, the way man's skills acts as a medium of Nature and her laws is never consciously reflected in their diagrams. Ritter's more problematizing stance is symptomatic of his distrust of hypothesis and theory. His empiricism may be highly philosophical, but it does (arguably) give Nature more of a fair reading; moreover, it is his concrete approach to empiricism that enables him to produce a more complex and (in terms of eighteenth century science) better theory of galvanism than Volta or Humboldt.

Ritter steers away from hypothesis through what I have referred to as "natural" practice, which is embodied in one way in the symbolic use of the nerve in the diagrams. As already intimated, "natural" practice implies, in general, treating inquiry as just as much an ultimate phenomenon as the galvanic process within Nature herself: in this sense, "natural" practice demands a truthfulness to Nature, imitating Nature using concrete "natural" models of it such as our perception of the nerve itself as a phenomenon (i.e. our awareness when perceiving the nerve that it is representative of general laws of Nature), and concrete "natural" models such as Ritter's concrete representation of the nerve in his figures. It is this, which involves bringing experience back into theory, that reflects Novalis's reevaluation of the notion of "experiment". For Ritter's use of the nerve employs a cognitive, experientially based form of knowledge; it operates "experimentally" according to Novalis's notion of concrete knowledge. Experience is brought back into theory in two ways: firstly, through viewing knowledge instrumentally and as a phenomenon, and, secondly, in constructing theory which remains close to experience in its imitating of Nature. Here, through the meeting and interpenetration of the inquirer's methodology and the concrete theory of the nerve, practice is unified.

In the introduction to the *Beweis* Ritter specifically refers to his self-conscious experiential stance, and employs it later in the empirical section of the *Beweis*:

> Wenn nun die Natur überall nach unverbrüchlichen Gesetzen verfährt, oder wie wir gewöhnlich sagen, wenn sie überall consequent handelt, wenn alles, was Product ihrer Thätigkeit ist, für uns Wahrheit seyn muß, und wenn uns bey aller Naturforschung nur diese Wahrheit zur Grundlage unserer Schlüsse dienen darf, so muß es *bloß an uns* liegen, wenn wir auf Widerspruch kommen, *wir* müssen nicht consequent verfahren seyn, denn, aus Wahrem kann nur Wahres folgen, und dieß mit neuer Wahrheit verbunden, muß abermals Wahrheit zum Product geben; - und hierin erblicken wir für uns die Möglichkeit, auf die einzig möglich wahre Theorie aller Naturerscheinung, durch sie selbst geleitet zu werden. Wachsamkeit über seine Thätigkeit muß also das erste Erforderniß des Naturforschers, Bekanntschaft mit Thatsachen, mit den Producten der Thätigkeit der Natur, das zweyte seyn. Das erste uns zu verschaffen, steht in unserer Gewalt, und das zweyte können wir jeden Augenblick haben. Offen und frey handelt die Natur, ihre Werkstätte hat weder Thüren noch Schlösser, Ruhetag hält sie auch nicht, denn rastlose Thätigkeit ist ihr Character (*R*, ix-x).

It has already been discussed how Ritter here is calling upon the scientist to look closely at his own interpretative activities to supervise how he is theorizing with the phenomena: "Wachsamkeit über seine Thätigkeit" implies self-conscious theorizing. It is, however, important to note that Ritter also demands that the scientist should have a sound practical knowledge of the phenomena: "Bekanntschaft mit den Producten der Thätigkeit der Natur" refers to a knowledge of the active, organized processes of Nature. Nature herself, in Ritter's view, offers the inquirer the basis for the possibility of investigation at all, and that is "durch sie selbst [*Nature*] geleitet zu werden". It is through the imitation of Nature, in Ritter's view, that the inquirer can arrive at a more coherent theory of phenomena. Nature herself supplies the basis for a type of theory that mediates between the natural processes under investigation and strict theory itself. Knowledge in the sense of practical activity and the activity of Nature herself is the key to Ritter's scientific matters, and, indeed, it is in this spirit that he remarks that Nature herself is endlessly active ("denn rastlose Thätigkeit ist ihr Character" (*R*, x)). The implication is that both knowledge and Nature are experiential, part of the same experiential whole, and that their link lies in practical, phenomenal forms of inquiry. The symbolic role of the nerve reflects the fact that in his work in the *Beweis* there is a link between inquiry and Nature, and that the nerve is the focal point for the dynamic theory of galvanism. Treating inquiry as an activity, "Thätigkeit", as a phenomenon in itself, requires that theory be espoused in a concrete form such as the nerve.

The notion that Nature and inquiry form a single entity allows the scientist to take the view that Nature speaks as an organic whole in the course of his "experimentation". The experiments in *figures 67-71* are presented in such a way as to let Nature alone appear to do the theorizing, firstly because Ritter's theorizing leaves Nature intact through the use of concrete symbol, remaining true to Nature, and secondly for the reason that all the experiments in these figures deal with wholes, the closed circuit and the nerve. No conductors are added in these experiments, nor are the circuits broken. The key to Ritter's "proof" is an organic whole, the nerve, and his theory is the "proof" of the vast organic whole, Nature. Volta and Humboldt do not think in terms of an organic whole, instead their experiments and theories point to a separateness in Nature. The "absoluteness" of Humboldt's conductors, or the specific material nature of his "Nervenfluidum", and Volta's static polarity of contact electricity all suggest a separateness, in Humboldt's case a materialistic separateness, in Volta's case a polar separateness.

Further, Ritter explicitly refers to the need for a phenomenal base for theory such as the nerve or the constant galvanic force, calling upon common sense in the following passage in the *Beweis* to show the traps of hypotheses and formal, conceptual theory. For, as mentioned, Volta's mechanical contact electricity produces a static abstract model of Nature, and also his hypothetical notion of a perpetuum mobile (*194*, 43; *142*, 30), where galvanic action is paradoxically purely brought about by the metals (this, as Ritter points out, overlooks the presence of a finite force in circuits). Humboldt's notion of substantial conductors, perhaps, taken to its logical extreme, suggest the theoretical impossibility of an infinite amount of conductors. Ritter, as well as criticizing the notion of endless conductors also speaks of the impossibility of an infinite "irritability", or of an infinite amount, or entire diminishment of "action" in a circuit:

> Aber ein unendlich hoher Grad von Erregbarkeit ist unmöglich, schon dadurch unmöglich, weil, wenn es dergleichen wirklich gäbe und gegeben hätte, der Uebergang zum endlichen, wie wir ihn finden, nur in einer unendlichen Zeit, in einer Ewigkeit, d.i. nie, geschehen könnte, und somit ist auch das letztere, das unendlich klein Werden von x [*the action*], das Verschwinden desselben unmöglich, und umgekehrt (*R*, 144).[18]

Ritter's argument here for the necessity, at a methodological level, for a phenomenal base for theory can be likened to Novalis's view of the role of phosphorus in chemistry. Thus, in the context of the notion of *experimentum crucis*, both Ritter and Novalis (and, of course, Goethe) argue for the centrality of the concrete substance to theory building. Whereas most science took the idea of "experiment" from the notion of *experimentum crucis* in an abstract way, the early Romantics also the include the concrete substance of the crucial instance.

To conclude, Ritter's symbolic use of the nerve was a profound example of a theoretical model that evaded the many pitfalls of inquiry. Through the "proof" of the existence of a "constant force", Ritter's deployment of the nerve as a symbol both gave natural philosophy valuable material for a notion of organization, and afforded the strictly empirical sciences a significant leap forward in electrochemistry. Importantly, Ritter's use of the nerve in his theory of galvanism and the reflection of its theoretical significance in his diagrams can be described in terms of the aesthetics - as a concrete form of knowing - of the individual inquirer's theory and methodology. This forms the base of Novalis's notion of the individual's natural philosophical productivity which will now be evaluated in the next section.

*9. Novalis's views on the individual's natural philosophical productivity: the fact of the nerve and "Experimentencalcul".*

Novalis's argument for the use of aesthetics and practical knowledge in inquiry has already been discussed in his important notion of "die Instrumentalsprache"; Novalis, however, delves further into the issue of practice and human agency in inquiry. Next to the comments he makes on the diagrams in the *Beweis* (see above, section 7), he remarks that each area of inquiry (the various disciplines and arts) unifies its form of practice in a specific symbol and that all of man's forms of practice are generally unified in Nature:

Die Natur ist die Einheit aller Künste und Handwercke. Es giebt aber noch solche Einheiten für die Gattungen - und Species und Vielheiten von K[ünsten] und H[andwercken]. Eine solche Einheit ist für eine Menge K[ünste] und H[andwercke], die Kleidung. Für Andre - das Gebäude u.s.fort (*N*, 3, 91).

This is another instance which reveals how Novalis links man's thought and Nature. In the remarks above Novalis is stating man's ability to abstract from his practical knowledge ("Künste und Handwercke"): the unities or symbols of man's practical skills are the result of his ability to produce concrete ideas which remain true to Nature. The above remark shows Novalis's fundamental interest in consensuality. The remark can be seen as a base for both Novalis's notions of consensuality, for the classification of the knowledge and the sciences, and for the individual's natural philosophical productivity, since both forms find their highest goal in the unity of knowledge with Nature ("Die Natur ist die Einheit aller Künste und Handwerke"). Novalis had such a unifying symbol in mind for galvanism, to him the unifying notion is indeed the nerve. Throughout his natural philosophical notes of 1798-1800 Novalis comes back to the theme of galvanism and makes his comments with Ritter's *Beweis* in mind. Novalis was highly aware of the significance of the nerve for galvanic theory and its role in revealing the inner dynamic processes of matter, and the importance of approaching nerve action itself in terms of inorganic activity. In the winter of 1799/1800 he remarks:[19]

Nerv ist das chémische, electrische und galvanische Agens (*N*, 3, 631).

Close to his remarks on Ritter's diagrams in the autumn of 1798 Novalis gives the nerve a special status as a cause of activity within organisms, since the nerve is the real entity at work behind the muscle contractions, operating on the principle of the physical and inorganic realm of "actio in distans":

Der Nerv ist *mehr*, als der Muskel ... Der Muskel nemlich *zuckt*, während der bewegende Nerv *ruht* ... Die äußre Wircksamkeit - die Sensibilitaet der Wircksamkeit wächst im Verhältniß der Entfernungen vom Mittelpunct oder Innern (*N*, 3, 101).

Novalis was clearly highly aware of the broader natural philosophical implications of the nerve, and here observes the proportional relationship between nerve-length and force. Significantly he emphasizes the idea of an organizing, sensible force when he refers to how the "Sensibilitaet" of the force increases proportionally to the distance. Thus Novalis was aware of the physiological and organizational implications of Ritter's galvanic experiments, and in reading the *Beweis* he saw the link between electrochemical phenomena and physiological phenomena, and the possibility of viewing electrochemistry in terms of organization.

Further, while discussing Ritter's diagrams, and later in the *Das allgemeine Brouillon*, Novalis speaks of "experimental method" and the need to base inquiry upon some fundamental fact, and proposes that experiments should be conducted as variations on this fact. In the context of galvanism, the fundamental fact is the universality of the inner dynamism in Nature, and the nerve is the particular symbol of this fact, and in this way a symbolic fact:

Reine Erfahrungen üb[er] die *Muskel* und *Nervenbewegung* - und Benutzung, Combination - Classification und Folgerungen. *Ausgang* von Einigen unbezweifelten Factis - wie in *d[er] Phil[osophie]* (*N*, 3, 427);

Das universalste Naturfaktum muß eine unendliche Reihe variirender Erscheinungen - *einzelner wircklicher Phaenomene - Experimente* - unter sich haben (*N*, 3, 91).

Novalis is describing a form of induction based around the aesthetics and practical knowledge of natural philosophical productivity, as evinced in his notion of a "phenomenal" calculus. It is an inductive procedure that begins with a significant, irrefutable form of experiential knowledge ("unbezweifelt", arguably the case with the nerve in galvanic theory). Here the human subject's knowledge of a natural object is based upon experience. As remarked, Novalis argues for the centrality of the concrete substance in the *experimentum crucis*, as opposed to taking the idea of "experiment" in an abstract way from the "crucial instance". Then the familiar, simpler notion of induction is suggested in "Benutzung". "Combination" refers to another more complex step of induction, where the experiments are varied in a form of "phenomenal" calculus, such as implied by Novalis's notion of "Experimentencalcul". "Classification" is, obviously, a common term of eighteenth century inquiry, as espoused by Linnaeus. More pertinent to Novalis here are Fichte and Werner. The manner in which Fichte lets concepts and phenomena interact is interpreted by Novalis as part of the classification process in experimentation (see above, chapter one, section 3). Werner's method of classification, as has been argued, sets constitutive rules and provides some form of a presuppositional framework for inquiry. This framework consists, in part, of both his methodology of directly theorizing with phenomena, and also in underlining paradigmatic types (such as those of his geognostical theory). Novalis explicitly points to such a framework when he suggests that Werner's types could be used in a "phenomenal" calculus. In the above remark, Novalis refers to such "Classification", and then to a more abstract stage of the procedure of experimentation, which closes in on the final stage of formulating theory ("Folgerungen"). Particular to Novalis's remarks on "experimental method" are the points which are part of his notion of "Experimentencalcul" (*N*, 3, 435). These points are, respectively, the first stage in the "inductive" procedure, which takes an accepted, "experiential" fact as its base, and the later stage which employs the fact in a process of "Combinatorik". In the context of Ritter's work it is significant that Novalis uses the term "fact" here. Naturally, the fact of the nerve can be used, like phosphorus, as a consensual symbol for galvanic inquiry. In this manner it could be used as the phenomenal base of future inquiry for galvanic practitioners. However, the term fact would appear to point to the higher version of consensuality found in the individual's natural philosophical productivity. The term "fact" illustrates the epistemological cohesiveness of Ritter's interdisciplinary approach. Out of the practical knowledge of the interdisciplinary "case study" he makes of galvanism Ritter arrives at what he considers to be the central phenomenon of galvanic inquiry: the fact of the nerve. Through his approach to galvanism the nerve acquires ever more significance and meaning. In this manner, the fact of the nerve is the result of the individual inquirer's practical knowledge.

In the further stage of his inquiry Ritter translates the significance of the nerve into his diagrams. There the theoretical significance of the nerve is realized in his scientific method: the theoretical implications of the nerve take concrete form. Here, the meaning of the individual's natural philosophical productivity is revealed, and this points to the potential of the diagrams for a higher level of consensuality. The theoretical implications of the nerve for galvanic theory and the realization of the nerve's significance in the diagrams make up the type of consensuality that the individual's natural philosophical productivity is communicating.

Turning away from the subject of consensuality, there are other issues relating to Novalis's interest in symbolism and notation, which provide a backdrop to his agreement with Ritter's form of inquiry. It is worthwhile to discuss Novalis's notion of a general calculus and his use of the idea of "Sympathie" in this context. As discussed, Novalis argues that calculus is akin to the process of analogy since it involves relating things to one another and assumes a link between inquiry and Nature. Moreover, the "asymptotic" notions of mathematical calculus are also akin to Novalis's and Ritter's notions of natural philosophical theory and inquiry, which speak "approximately" or "transcendentally" (and not "absolutely") of nature through the mediation of notational symbols, drawing on the relationships of things with another and their "Combinationen":

Der menschl[iche] Geist kann die äußern Symptome und ihre Compositionen approximando nachmachen - er muß also Analogie mit den Bestandtheilen und *Naturkräften* haben - ... (*N*, 3, 426).

This is an illuminating statement of Novalis's notion of inquiry, in that it restates the idea of a "sympathy" between observer and observed in analytical terms. "Compositionen" and "Bestandtheilen" refer to the constituent parts of a single phenomenon, which are here considered as "analogically" and "approximately" related to the inquirer. Accordingly, one can see Ritter's concrete use of the nerve in the diagrams as an example of a form of theory, depending on a "Sympathie" which "asymptotes" towards Nature, and that draws on the relationships of things to one another ("Verwandtschaften"). In the case of the nerve in particular, in Novalis's sense of analogy, a relationship between knowledge and Nature has been established. In the way the nerve is employed in a process of inquiry it becomes in the broadest sense a fact, "eine Tatsache", literally an "action-thing", since as a phenomenal archetype it reveals for dynamic theory that inner forces are constantly at work in Nature. By "imitating" the nerve, inquiry itself becomes a process of concrete practical knowledge. Using the nerve as a fact, in the above manner (as a phenomenal base for theory), Ritter, from Novalis's perspective, carries out a "phenomenal" calculus where he can "predict" what will happen in galvanic circuits. The nerve becomes the important fundament of the "phenomenal" calculus of the diagrams, where the "Combinationen" of the individual components of the diagrams, i.e. the process of drawing relationships of the phenomena with another, forms a "Combinatorik" of discovery. And indeed, it was Ritter's introduction and his particular use of the nerve in his galvanic experiments, both in the sense of his method of inquiry and through viewing nerve action not specifically in the light of the organic realm, but also as part of the general force of galvanism throughout Nature, that cleared up the inconsistencies in Volta's and Humboldt's theories. Furthermore, it enabled Ritter in 1798 (unlike Volta and Humboldt) to develop a more predictive theory.

Novalis's interpretation of Ritter's diagrams as a "phenomenal" calculus thus accounts for the diagrams as particular formulas or "Chiffre" of Nature ("Instrumente und Apparate sind *reale* indirecte *Formeln. Maschinen sind Formeln*. (Ritters Figuren) ..." (*N*, 3, 91)). The nerve provides the "constant factor" in the "calculus" of the "Combinationen" of the phenomena under investigation. Seen in general terms, the dynamic theory of matter implied by the nerve action was the "constant factor" in the theory of galvanism. Novalis was clearly aware of the alternative views of Volta. As discussed, Humboldt's substantial conductors and Volta's polar electricity were not the key to galvanic theory, it was rather that conductors and the closing of circuits espoused in mechanical contact electricity were relative factors in the galvanic equation. Novalis remarks:

Voltas Theorie des Galvanismus (Elektr[ische] Statik und Mechanik) (*N*, 3, 95).

Here, Novalis implicitly sides with Ritter in distancing himself from Volta, whose theory, in Novalis's view, reduces galvanism to a mechanical phenomenon.

Within the context of the representative nature of Ritter's diagrams, the symbolic nerve and the "predictive" nature of Ritter's diagrams, it is further illuminating and worthwhile to look at Bergman's affinity tables. In an analogous way they can be seen as developing the sort of tradition of scientific diagrams which Ritter's belong to. Bergman's affinity tables may not look similar to Ritter's galvanic diagrams, and naturally their subject matter was different, yet Bergman's affinity tables, at a deeper level, provide an important precedent for Ritter's particular type of diagram. Like Ritter's diagrams, his affinity tables were schematic representative models, and they also can be seen as a kind of "phenomenal" calculus. Bergman's programme could, in Novalis's terms, be read as a "calculus" of chemical relations: if *all* the diagrams were completed, it should be possible to predict every chemical relation.

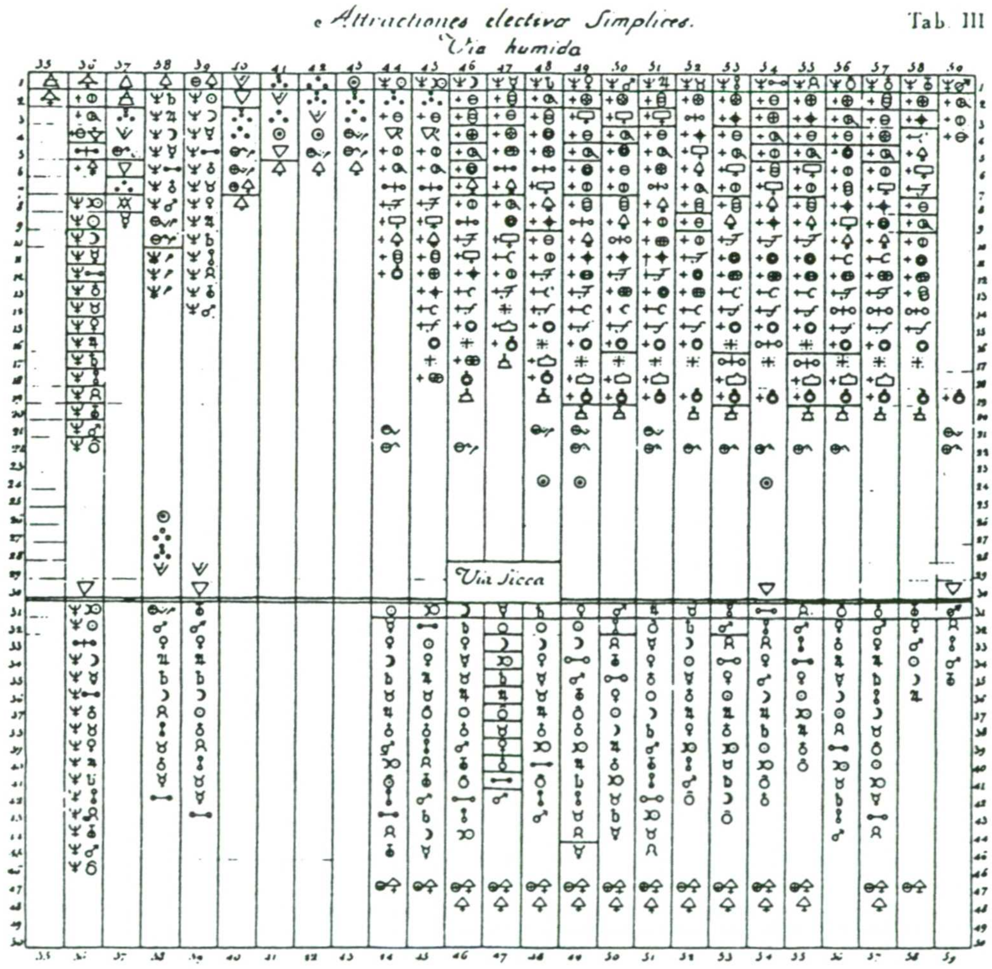



*Fig.12. T.O.Bergman, Affinity table, 2, 1783 (10).*

Moreover, alchemical diagrams in their symbolism, such as the one in *Quadratum alchymisticum* (see above p.234), also form part of the tradition espoused in Novalis's notion of concrete theorizing in diagrams. In particular, of course, the Lullian tradition of "Combinatorik", and the way things are related to one another in its form of "Combinationen" in diagrams, comes close to Novalis's idea of a "Calcül" of concrete theorizing. Novalis's notion of a "Combinatorik" using diagrams is, however, less abstract, since he proposes the use of "imitations" of Nature, such as Ritter's symbolic nerve. None the less, in general terms of a "Combinatorik" of concrete knowledge, Novalis's notion of knowledge comes exceedingly close to Lullism. This is a major cross over point between Neoplatonism and Novalis's thought.

Furthermore, in the broad context of the representation of theory and concrete theorizing, Faraday's diagrams for field theory, as Gooding describes them, in the way they pave the path to a more coherent theory (as do Ritter's diagrams) and in this sense improve the "predictability" of theory, can also be interpreted as continuing the tradition of scientific diagrams to which Ritter belongs. Clearly, too, the examples given here illustrating this tradition of diagrams all have great consensual potential, for they all communicate theory in a concrete manner and provide a possible basis for constitutive rules in inquiry.

*10. Individual natural philosophical productivity as a programme. The role of Ritter's* Beweis *for Novalis's programme of practical knowledge.*

The consensual significance of Ritter's work, as spelt out in terms of the unifying of practice in the realization of the individual's methodology and theory based upon practical knowledge, can also be interpreted in the light of remarks Novalis makes at a most general level on natural philosophical productivity. Before making this comparison, it is necessary to provide some backdrop and to illustrate how Ritter's thought suits Novalis's notions of ontology, and, also, to reflect again how central the subject and aesthetics are to their form of inquiry.

Importantly, when Novalis made his observation on the proportional relationship between nerve-length and force, and on the way the "sensibility" of the force increases proportionally to the distance, he also linked the nerve up to, and explained it in terms of, his fundamental view of the nature and origins of knowledge and organization. He remarks:

Der Nerv ist *mehr*, als der Muskel, weil aller Anfang insensibel ist (N, 3, 101).

The nerve is an example of the ideal creative force in Nature. It can be understood that, in Novalis's view, the origin of the organized world (obliquely referred to in "aller Anfang") lies in an "experiment" of the ideal (hence Novalis speaks of "insensibel" referring to the realm of pure intelligibility). Elsewhere he also refers to the origins of knowledge in a natural philosophical context, indicating the "ideal" or "spiritual" basis of physics and concrete Nature:

Der Geisterwelt gehört das erste Capitel in der Physik (*N*, 3, 601);

Fuga Vacui./ *Geschichte der Physik.*/ (*N*, 3, 86).

The two notes suggest in different ways that the realm of ideas, determined by a commonly accepted law of Nature, abhors a vacuum, and by means of a purposive physical force produces matter. By beginning with the "ideal" realm, but understanding it in the context of physics, Novalis interprets the Chain of Being as "Nature" in her entirety. In the light of "Sympathie", and in Plotinos's notion of the One's self-conscious reflection upon himself, the universe was created out of a fundamental "experiment". For Novalis, in this sense, "experiment" is a self-conscious, concrete thought. Furthermore, in speaking of a fundamental "experiment", Novalis powerfully conveys his belief that knowledge, method and science are part of a "spiritual" and historical process. Thus, indeed, "Physik" arose, which is both knowledge (study of matter) and Nature herself, where matter is seen as bound up with a purposive force. Novalis saw that Ritter's work on galvanism strove to explain this historical process through his description of the purposive force of galvanism. It is precisely in Ritter's method of inquiry, as expressed in his diagrams, that Novalis felt that Ritter had come so close to an understanding of Nature's purposiveness. The diagrams are an invented language of Ritter's, and in terms of Novalis's epistemology of "phenomenal" languages, and his notion of the "Figuren" and "Chiffernschrift" of Nature, the diagrams reflect how successfully Ritter had internalized galvanic phenomena in his creative inquiry. Internalizing Nature, for Novalis, implies an inner experience of Nature: the diagrams are a product and a reflection of this process. Ritter's diagrams represent the galvanic language of Nature since they put the inner processes of Nature into visible form. That Novalis profoundly accepted Ritter's method in the *Beweis* is shown further in his comments from the middle of 1800 where he directly links his epistemological notions with experimental method and refers explicitly to Ritter:

> Ritter sucht durchaus die eigentliche Weltseele der Natur auf. Er will die sichtbaren und ponderablen Lettern lesen lernen, und das *Setzen* der höhern geistigen Kräfte erklären. Alle äußre Processe sollen als Symbole und lezte Wirkungen innerer Processe begreiflich werden. Die Unvollständigkeit jener soll das Organ für diese und die Nothwendigkeit einer Annahme des Personellen, als lezten Motivs, Resultat jedes Experiments werden (*N*, 3, 655).

Here, as elsewhere in Novalis, Nature is seen as a language, a "Chiffre". It is the nerve which is symbolic of the internal galvanic force ("Alle äußre Processe sollen als Symbole und letzte Wirkungen innerer Processe begreiflich werden"). Novalis appears to be suggesting that the nerve is a "letter" ("Chiffre"), the reading of which explains why we postulate ("Setzen") higher forces ("Kräfte"). Novalis also appears to be punning upon the two meanings of "Setzen", as the "setting" in printing, and as the act of postulating. In this manner, Nature postulates its forces in the "language" of its phenomena and their forms. Further, as implied in Novalis's notion of knowledge, mind and matter, the inquirer's knowledge and

Nature are uniquely linked in symbols and in the essence of their being: man's consciousness reflects Nature's purposiveness. Nature is the "Organ" for man's inquiry, that is, man speaks through Nature in his inquiries. In this sense, Novalis speaks of "das Personelle" that should be accounted for in "experimentation". Ritter exemplifies "das Personelle", by individualizing the purposive force of Nature, both in his method, and in his notion of Nature itself through his internal constant galvanic force, and consequently in his vision of Nature as an organized, living whole, "das All-Thier". Ritter makes the higher forces concrete. In this way, because of the sensual *a priori*, concrete internalization of Nature in his diagrams, Novalis saw Ritter as speaking Nature's language and as having created a language on Nature's terms.

It is this aspect of Ritter's work that provides some solution to the problems surrounding the role of the subject in inquiry. Romantic subjectivity, when seen in the form it takes in Ritter's work, does play a major role in the attainment of knowledge. It has been demonstrated that aesthetics and natural philosophical productivity do bring about cognitive gain. In his method of inquiry, Ritter relies upon his practical skills and his practical knowledge of Nature to act as a medium between man and Nature. Indeed, Ritter's diagrams externalize his subjectivity: they grant objectivity to subjectivity through their concrete form and act as a useful tool allowing the experimenter to theorize with the phenomena. Further, a concrete link between knowledge and phenomena is found in the subject's role in a continual process of inquiry, where formal truths are not sought. Instead a practical, concrete form of knowledge is argued for, on a view which accepts the limits of man's knowledge of the natural world, and which perceives the attainment of truth as a process within an experiential whole.

That the diagrams are tools in a process of discovery is most important in view of Novalis's experiential notion of knowledge. If one merely sees Ritter's diagrams as a reflection of his galvanic theory (and in a sense of the predetermined predictability of formal calculus) and not as part of a continual process of inquiry, then they appear as a reflection of a subjective, speculative theory, a theory that just assumed from the very start that galvanism was a dynamic activity. The diagrams do, however, reflect a process of discovery, and offer a phenomenal argument for a new theory: they are part of a continual theorizing with the phenomena where the subject is not given absolute status in inquiry, but plays the role of a mediator. In the process of Ritter's inquiry, the use of the subject is unavoidable: the subject is permanently interpreting the phenomena until a completed objective theory is obtained. In the creation of a theory, the subject is always in contact with the phenomena and must put forward phenomenal, non-conceptual forms of argument, because formal theory has not yet been obtained.

In this sense the diagrams are used progressively throughout the *Beweis* to create a theory and not to prove some hypothesis: as the *Beweis* goes on, the formal theory becomes clearer. In terms of Novalis's epistemology, Ritter has not just concretized theory into a form of "phenomenal" calculus, but has translated phenomena into a concrete, non-verbal form of theory. In this form of induction, there lies indeed a role for the subject as the initiator of experiment and theory. Thus, the aesthetics of natural philosophical productivity, as a method based on the subject's concrete forms of knowledge, play a key role in Ritter's pioneering work on galvanism.

Interestingly, Novalis himself drew up a diagram which concretely visualizes Ritter's thoughts in the final, speculative part of the *Beweis*, where the relationships between galvanism, electricity and chemistry are treated (*R*, 172-3). Novalis's diagram can be seen as a non-verbal representation of Ritter's speculations, and reflects Ritter's working method (see below *Fig.13*).

Figur.vid.Ritter *(Kugelform)*

Chymie - Galvanism - Elektricität - Magnetism (*N*, 3, 83).

*Fig.13. Novalis's symbolic representation of Ritter's notion of galvanism.*

Novalis's diagram symbolizes the union of electricity, chemistry and magnetism under the over-arching concept of galvanism. Novalis extends Ritter's notion of a circular circuit of galvanism ("Kreis", *R*, 172) to a sphere ("Kugelform") symbolizing the galvanic whole of Nature and includes the force of magnetism. In the critical edition of Novalis's works a reference is made to Ritter (*N*, 3, 846, 848), but no explanation is given of the diagrams, nor do any critics remark on the diagram in terms of Novalis's concrete thought. The arms in the diagram refer to the various dynamic processes: they symbolize, respectively, the electrical, the magnetic and the chemical effects of an "action" taking place between conductors. The bars or partitions which divide the two arms respectively signify the forces of electricity and magnetism, where action takes place without the production of a new "individual". The arm where the partition is dropped (and where the line runs within the bar) symbolizes chemical action; here, the qualities of the two acting "individuals" have been transformed and a new whole "individual" has been created. Novalis's diagram is thus a visual formula of the various dynamic actions in Nature. Its existence bears eloquent testimony to the role of Ritter's work in his thought, and demonstrates how he actually sought to build on Ritter's achievements.

Novalis's diagram can be understood as an epitome of Ritter's thought, and to grasp it fully, one must interpret it within the whole context of Ritter's *Beweis*. For when Novalis's diagram is related back to the diagrams in the *Beweis*, it can be seen how Ritter's diagrams perfectly illustrate Novalis's entire notion of an "experiment". As a constituent of completed theory they are, in an epistemological sense, a formula of Nature; but crucially, as indicated, they are also part of a "calculus" of discovery, i.e. a process of discussing and interpreting phenomena in a cognitive way, as expressed in Novalis's notions of "Experimentencalcul" and "Instrumentalsprache". The diagrams are tools which assist in a "phenomenal" calculus of discovery, where the experiments themselves, the instruments, and theoretical view-points are varied and combined. Moreover, in a greater context, Ritter's *Beweis* is, for its part, the epitome of Novalis's idea of historical, progressive, "experimental" inquiry; for Ritter has, in Novalis's sense, sought to reveal the "Lettern" and "Kräfte" of Nature. Ritter's concrete theory in his diagrams is, for Novalis, the galvanic language of Nature. Novalis's reference to "Lettern" and "Symbole" in his remark on Ritter's method (*N*, 3, 655) can, significantly, be associated with the terminology Novalis uses in his important statement on the Golden Age, in which he relates the coming of the Golden Age to his own idea of method, "Plastisirung". Here one can see how well Ritter's work suited Novalis's notion of inquiry, and, ultimately, his views on consensuality and the programme for individual natural philosophical productivity.

In these important remarks of Novalis on his method (and these can be interpreted as his fundamental philosophical grounding of consensuality), "Plastisirung" (also called "die ächte Experimentalmethode") is the process where concrete forms of knowledge are used. These Novalis refers to as "Figuren" ("Dort waren Figuren etc. ... nöthig"). In the opposite method he suggests, "die Beobachtungsmethode", a conceptual procedure, Novalis proposes that "Worte" are used ("hier Worte etc. nöthig" (N, 3, *123*)). What Novalis suggests in his theory of concrete language is that concrete and conceptual procedures of thought and inquiry should be juxtaposed, and used as steps in coming progressively closer to an entirely concrete understanding of Nature. It should be stressed that Novalis does not strictly separate thought into the concrete and the conceptual, and, instead, in his suggested method, argues for an on-going exchange, unification, and interpenetration of the concrete and conceptual:

Worte und Figuren bestimmen sich in beständigen Wechsel ... (*N*, 3, 123)

He then further expresses the interpenetration of the concrete and conceptual when he introduces the terms "Wortfiguren" and "Figurenworte". Those "Worte" which are of particular concrete significance he terms "Wortfiguren". The "Wortfiguren" are man's translation and perception of the "figures" of Nature, understood by the inquirer as the "Worte" (the language) of Nature. The "Wortfiguren" can be understood as idealizations of phenomena, such as Ritter's diagram of the nerve, where the nerve is selected for its particular significance as a phenomenon:

Die Wortfiguren sind die Idealfiguren der anderen Figuren (*N*, 3, 123).

The pregnance of Novalis's expression allows, too, an understanding of how language itself is phenomenal, and how phenomena themselves form a language; for "Wortfiguren" refers both to the particular symbolic significance of an object such as the nerve (one of Nature's "Figuren"), as a phenomenon itself, and the meaningful, hieroglyphic nature of Ritter's symbol of the nerve in his diagrams.

On the other hand, "die Figurworte" are the particularly significant images in the mind, which are seen as an ideal language themselves, for here the inquirer is thinking purely concretely:

Alle Figuren etc. sollen Wort oder Sprachfiguren werden - so wie die *Figurenworte* - die innern Bilder etc. die IdealWorte der übrigen Gedancken oder Worte sind - indem sie alle innre Bilder werden sollen (*N*, 3, 123).

The ideal language ("die IdealWorte") Novalis refers to is a symbolic language of meaningful images. This is again found in Ritter's use of the nerve in his diagrams, and, indeed in the general nature of the diagrams in the *Beweis*; for these are, in terms of Novalis's thought, an inner concrete language of images, which have tapped into the language of Nature herself. They are man's inner "Figurenworte" of phenomena, and reveal the link between the concrete processes of the mind and the "language" of Nature. The realization of "Figurenworte" belongs to Novalis's ultimate aim that the inquirer should express his theory in the language of Nature.

Thus, in the interpenetration and unification of the concrete and the conceptual, the more conceptual process of "die Beobachtungsmethode" (which uses "Worte"), becomes the attempt to convert our concrete perception of phenomena, or our images of phenomena, into "Hieroglyfen". This is the process where the "Figuren" of phenomena can be "spoken" and "written"; and the concrete process of "die Experimentalmethode" becomes the attempt to convert our inner notions into concrete images and a concrete language. The Golden Age Novalis envisions will come when knowledge in this way becomes an entirely concrete process:

Das wird die goldne Zeit seyn, wenn alle Worte - *Figurenworte* - Mythen - und alle Figuren - Sprachfiguren - Hieroglyfen seyn werden - wenn man Figuren sprechen und schreiben - und Worte vollkommen plastisiren, und Musiciren lernt (*N*, 3, 123-124).

It is important to note how Novalis aims to unify the "conceptual" with the concrete. In essence, phenomena are concretized into "Hieroglyphen", and thought in general becomes "Figurworte". Crucially, these then take on the full body of narrative ("Mythen"), which then provides the literary form of the scientific insight. Novalis's main proposal is that an inner language or logic be constructed which is in harmony ("Musiciren") with natural phenomena. He stresses this when he remarks:

Der Fantasie, die die *Figurenworte* bildet, kommt daher das Praedicat Genie vorzüglich zu (*N*, 3, 123).

This would appear to be the crucial step, that man realizes the "Sympathie" between himself and Nature; this is the step taken by the "Genie" with his "Gefühl". Without this initial step of a conscious awareness of "Sympathie", the patterns and "Figuren" of Nature herself have no meaning. Man has to construct an inner language to convey the universal "Sympathie" of Nature, in order to form a meaningful relationship between himself and outside phenomena. And it was Ritter, in Novalis's view, who was such a "Genie". When Novalis speaks of Ritter reading the "Lettern" of Nature, of his "Setzen" of Nature's language in an inner language of the mind, and of Ritter's "Symbole", he is referring to these notions of "Worte" and "Figuren".

One can link Novalis's comments on Ritter's method with his remarks on "Worte" and "Figuren" in the following way. The "Lettern" of Nature are the "Figuren" of Nature; the "Setzen" of Nature can also be seen as Nature's expression of herself in the "Figuren" of phenomena, and as the inquirer's conversion of natural phenomena into an inner concrete language of the mind. The "Symbole" are both the "Figurenworte" of man's inner language, and the phenomenal language of the "Figuren" of Nature. In its combination of theory and phenomena in an entirely concrete process of knowledge, Ritter's *Beweis* is a step towards the Golden Age, the time when the inquirer and Nature will be one.

Thus the dynamic organic whole of Nature and the nerve are in Novalis's view both phenomena and theory, just as Ritter's diagrams themselves are both theory and phenomena. The final "predictive calculus" of the diagrams, the theory, is justified by the concrete inductive proof afforded by the cognitive inquiry into phenomena, which is itself a "phenomenal" calculus operating on the fundamental "Sympathie" between the genius's thoughts and phenomena. Predictability was only attained through the discovery process, where Nature's "Figuren" were translated into man's "Figurworte". In this way, Ritter's work on galvanism is a paradigm for Novalis's notion of natural philosophical productivity, and fulfilled this idea of Novalis's historical, progressive and "experimental" inquiry where human consciousness becomes one with Nature's purposiveness.

It has become clear just how important aesthetics and practical knowledge are to Novalis's and Ritter's notions of inquiry. Some aspects, too, of the ethical elements of early Romantic natural philosophical thought have become apparent in their concern for experiential knowledge and the manner in which they respect Nature through their awareness and ability to express her purposiveness in their forms of inquiry. Finally, Novalis's programme for the unifying of practice is readily visible in Ritter's galvanic investigations. Theory is viewed as practical knowledge and approached in an interdisciplinary manner akin to a case study; the individual's methodology, on the other hand, gives practical expression to theory in the concrete form it takes. Ultimately, both forms of practice merge in Ritter's practical understanding of galvanic phenomena. This is a highly significant case of consensus in Novalis's thought, and, most probably, for early Romantic science as well. The ramifications of Ritter's work and of Novalis's programme for inquiry and knowledge will now be further reflected upon in the conclusion.

# Conclusion

## Unifying practice: a perspective for intellectual history.

*1. Novalis scholarship and Romantic science*

*2. Intellectual history*

*2.1 Science and aesthetics: the metaphysical and less metaphysical assumptions of the rhetoric of "experiment" and "phenomenal" calculus.*

*2.2. Literature and science: the plurality of discourses and perspectives on a common intellectual field.*

*1. Novalis scholarship and Romantic science.*

In the context of Novalis scholarship, this dissertation is one of many that has attempted to illustrate Novalis's thought in terms of an idea. It has been demonstrated how, at a variety of levels, Novalis's thoughts cohere and develop under the notion of "experiment", with all its implications for a general theory of productivity and knowledge formation. There are certainly other key aspects of Novalis's thought, such as his utopian notions, or his political, historical, and literary views. However, since natural philosophy is, arguably, the matrix of his thought, the explanation of his notion of "experiment" is of significance for his whole thought. In the light of his notion of "experiment", a development has been traced in Novalis's thought from a crucial point of reflection over the philosophical style of Kant, through to Herder, Goethe, and Werner, and to renewed reflections upon Fichte. Novalis's remark on "Diogenes Gehn" was interpreted as being emblematic of his attitude to inquiry, which is that knowledge and life have to be viewed as a continual "experiment". A further major point of reflection was found in Plotinos, where ontology, epistemology and natural philosophical productivity all merge as one programme for inquiry. In his reception of Plotinos, Novalis draws Neoplatonism, empiricism and German Idealism together as the basis for his notions of "phenomenal" calculus and practical knowledge. It is then, finally, in Ritter that Novalis finds his idea of inquiry realized.

In the introduction, aspects of postmodernism and intellectual history were explored in relation to Novalis scholarship. Instead of von Molnár's tendency to an absolute ethics, although of value for illustrating the practical concerns of Novalis's poetics, it was proposed that Novalis's natural philosophical thought puts forward a type of lower level consensuality, of a less demanding nature. The symbol of phosphorus was taken as an example of a more practicable kind of social knowledge. It has been considered how Novalis's grasp of phosphorus entails social dimensions, yet its rhetorical-dramatic use has strong epistemological elements. Further, some aspects of ethical elements have been found in Novalis's natural philosophical thought, as intimated by his desire to maintain the essential experientiality of thought and to respect the purposiveness of Nature. Indeed, it would appear that the crux of Novalis's notion of a communal language lies within the realm of his natural philosophical thought. The programme leading to the attainment of the Golden Age where humanity can "freely plasticize" is, above all, a natural philosophical enterprise - in its broadest sense - and this, as has been argued, is most completely fulfilled in Ritter's work on galvanism.

Novalis's interpretation of phosphorus also raised the idea of pluralism, which is implicit in Novalis's urge to classify knowledge. In the course of this work, an attempt has been made to underline two major strands in Novalis's thought: the unifying of theory, and the unifying of practice. This stance is akin to Neubauer's view of the centrifugal and centripetal forces at work in Novalis's understanding of knowledge. Ultimately, this dissertation argues more for consensus at what Neubauer calls the centripetal level - but this step is not undertaken by Novalis in quite so distinct a fashion. Novalis's reception of Ritter's work shows a significant reflective dimension to the inward direction of the consensus he attained. In the case study approach, theory is relativized, and the individual inquirer creates theory anew through practical knowledge. The outcome of such a method of inquiry cannot, naturally, be seen as a classification of the sciences. This final pattern of Novalis's thought has an inward motion expressed in the unification of knowledge in a particular realm of study. Practice is unified by drawing practical theory and realizations of methodology together, as illustrated, respectively, by the manner in which Ritter places the nerve at the centre of his new "theory" and also emphasizes the theoretical significance of the nerve in his diagrams.

As concerns further aspects of Novalis scholarship, in the introduction links were shown between the views I am proposing and Uerling's notion of narrative construction. I would like here to reflect further upon a key instance in Novalis scholarship, that of Frank's interpretation of Novalis's pattern of thought as "Ordo inversus". Novalis's notion of "experiment" can be accommodated to this interpretation. "Ordo inversus" implies the manner in which "Gefühl" and "Reflexion" in the "Ich" can be employed transreflexively (*354*, 117; *315*, 76). This pattern of thought very much accords with Novalis's notion of the interpenetration of "die Experimentalmethode" and "die Beobachtungsmethode", or of "Figur" and "Wort". In general terms, this is a mediation of the concrete and the abstract. The notion of "Ordo inversus", as described by Frank, can thus be viewed in the light of Novalis's natural philosophical productivity: it is a transreflexive activity, which brings man's consciousness and Nature's purposiveness closer together.

As concerns early Romantic science, it has been shown that its major proponents do have an experimental method. Their concerns are both thoroughly experiential - knowledge and life are viewed as an experiential whole - and they have a common methodology, which relates back to the experimental tradition. It is particularly within the realm of practical knowledge and the aesthetics of their natural philosophical method that they have been seen to have major affinities, and, it is in examining this area that the present dissertation offers a modest synthesis of early Romantic science. Significant, too, was the manner in which Goethe was working closely to the early Romantics, specifically at the level of method and methodology.

In this depiction of early Romantic natural philosophy, the danger of relativizing the Romantics' stance to inquiry has been combatted by my attempting to illustrate how their unifying urge is centred around their concern for practice. The open-endedness of their ideal types has also been seen to be modified by this interest in practice, and further by their appeal to a real phenomenal base for their ideal types. The Neoplatonic tradition, it has been seen, has played no small role in their methodology. The notion of continuity is rehearsed in a variety of ways in their thought: as the Chain of Being, as a series of experiments, as a series in a classification system, as a series in the visual language of Ritter's diagrams, and, also, in language as series of symbols leading to meaning. Novalis's notion of "Combinatorik" or "phenomenal" calculus is based to a great extent on the notion of an underlying continuity, and, of course, in particular on the idea of "Sympathie".

*2. Intellectual history.*

*2.1 Science and aesthetics: the metaphysical and less metaphysical assumptions of the rhetoric of "experiment" and "phenomenal" calculus.*

Novalis's idea of "experiment" has been considered at a variety of levels: in terms of his thought itself, in terms of contemporary science and thought, and in terms of modern thought. Novalis's idea of "experiment" has been interpreted as a tool capable of offering possible solutions to the regresses of postmodernist views on scientific method and language. Thus, Novalis's idea of "experiment" has, to some extent, fended off relativism at various levels, such as that found in the idea of a social construct of knowledge, in the notion of the "Experimenter's Regress", and in Derrida's linguistic regress.

I wish now to go beyond this point, to employ Jardine's views on aesthetics for exploring the applicability of Novalis's, and, consequently, of early Romantic notions of inquiry, to modern views on the role of aesthetics in consensus attainment in the sciences. Jardine stresses the fundamental role of aesthetics in interest and network theory. Importantly for this dissertation, he goes on to consider epistemological aspects of aesthetics. He remarks on interest theory and network theory:

Both approaches imply the fundamental importance of the process whereby a community of interests is established between promoters and recipients of claims and techniques. Literary and visual strategies for the advertisement of advantages accruing from acceptance of claims and techniques play obvious parts in the establishment of such mutual interests (*210*, 194-195).

Significant in this context is Jardine's focus on both literary and visual strategies as points around which scientific debate may revolve. On network theory Jardine comments further:

In network theory central roles in the attainment of consensus are assigned to the "chains of command" ... Such chains involve "cascades of representations" in which descriptions of phenomena are progressively abstracted, simplified, scaled up or down, in the interests of impact, comprehensiveness and amenability to combination, replication and analysis. Aesthetic and literary appeal and sensibility clearly play major parts in the operation of such cascades of representations (*210*, 195).

Clearly, network and interest theory, when developed on a large scale, have considerable potential for explaining the processes leading to consensus attainment. This dissertation makes no attempt to compete on this scale over strategies concerning consensus attainment. However, it does wish, tentatively, to contribute propositions that counter the view that knowledge is a social construct. Jardine, although concerned with the social factors of aesthetics, is also interested in epistemological factors. He dedicates a section to "The very possibility of a reliable aesthetics" (*210*, 208-224). Accordingly, Jardine also deals with the "intellectual" aspects of aesthetics. This dimension of his thought I would like to describe as "active intellectualism". Keeping Jardine's position in view, and before letting interest and network theorists entirely take hold of the field of investigation into consensus attainment, I wish now tentatively to explore some epistemological aspects of consensus attainment: it will be seen that there is such a thing, perhaps, as cascades of epistemological stances to consensus. Above all, I wish to argue that the issues of individual knowledge, when combined with the details of inquiry and seen in the light of epistemology, have, too, a valid role to play in consensus attainment. In this manner, some bridging points will be provided between the notion of early Romantic inquiry and a modern view of inquiry such as Jardine's.

Naturally, some cautionary remarks must be made before embarking on this comparison. For instance, the notion of unifying practice through forms of continuity or "Sympathie" are clearly too metaphysical a basis to be merged with Jardine's approach. Besides, the issues involved in case studies and practical knowledge as discussed in the context of this dissertation may be too broad to be readily generalizable. The proximity of "res" and "verba" in Novalis's understanding of Ritter's work seems, again, to be operative more at too metaphysical a level. Yet notwithstanding these cautions, some accommodation seems possible.

I wish now to underline some arguably fundamental areas of compatibility between Jardine's view of the role of aesthetics in inquiry and early Romantic views of inquiry. I will, first, briefly summarize Jardine's approach and his arguments for the reliability of aesthetics. "Reliability" refers to the need to calibrate the value of aesthetics for inquiry. Calibration itself rests in general upon the viability of a particular form of inquiry in terms of precedents and standards. This aspect is important to early Romantic methodology since the Romantics are highly conscious of the history of knowledge and of nature, and, indeed, of the "history" of the inquirer's own discovery processes. Jardine feels that aesthetics have been all too often employed in a negative manner in the history of science:

> In assessing the implications of the rhetorical and aesthetic strategies of the sciences it is, I believe, seriously misleading to concentrate as is the wont of many sociologists of science on the strategies that are most obviously suspect on the score of reliability (*210*, 208).

In Jardine's view "there are many rhetorical and aesthetic strategies that have solid claims to reliability" (*210*, 208).

When speaking of the amenability to calibration of aesthetic criteria in the sciences, Jardine further comments that aesthetic theories that emphasize "beautiful realization and embodiments of functions and processes" obviously favour calibration (*210*, 223). This I would like to see as a viewpoint found also in early Romantic science, where the "embodiments of functions and processes" may be correlated to the purposiveness of nature. Jardine also comments that aesthetic theories which "impose strict conditions for aesthetic competence" are also more amenable to calibration (*210*, 223). Again, I would like here to point to early Romantic science and the epistemological rigour of aesthetic elements in their notion of inquiry, as expressed, for instance, in Novalis's wish for a process of progressive experimentation. This is a process, embraced in his notion of a "phenomenal" calculus, which makes explicit use of the inquirer's aesthetic faculties. It is a process that aims continually to refine the results of experimentation and the experimenter's own perception of phenomena. Furthermore, Jardine sees the calibration of methods based on aesthetics as being "of crucial importance for our estimation of the claims of science to have attained a modicum of reality in the questions they pose and of truth in the answers they deliver" (*210*, 224). Once again, I would like to underline that the early Romantic consideration and employment of aesthetics in their approach to experiential and progressive knowledge, as found for example in Ritter's experiments, provides a possible instance of such a calibration.

Jardine offers us some "rationales" for aesthetics in the choice of hypotheses and theories. Firstly, the most central and "obvious rationale involves the assumption that the aesthetic virtues to which appeal is made are virtues of natural processes or states of affairs". Thus, "the truth of theories is held to be indicated by their aesthetic virtues because true theories reflect the aesthetic virtues of nature herself". Secondly, when aesthetic virtues are held to be genuine properties of observed natural processes, then "cognizance of the relevant explanatory or organizing theory or hypothesis is taken to contribute to an aesthetic competence". In this manner, for instance, "grasp of the Copernican cosmology contributes to an aesthetic competence to experience the dynamic harmony and unity of plan in the night sky". Finally, aesthetic competence "makes possible, or, at least, facilitates perception of aesthetic virtues in representations of phenomena" (*210*, 215-216). Again, given the early Romantic concern for aesthetics in scientific productivity, for the purposiveness of nature, and for the relationship between man's consciousness and nature's purposiveness, there are grounds for compatibility here. Novalis's understanding of the parallels between the observer and the observed, as expressed in his notion of "Sympathie" and frequently refined, especially in connection with Ritter, represents a close parallel to Jardine's theory. This provides a release from both relativism and the vicissitudes of postmodernism.

Jardine further lists the common attacks made upon such rationales for aesthetics, and goes on to defend the rationales. This is not the place for a full response to these objections, and I will only briefly list the cases he mentions and respond to them very generally in terms of early Romantic views on the role of aesthetics in science. The objections are: the primary qualities treated by scientific laws cannot be related to the secondary qualities treated by aesthetics; the transposition of aesthetic knowledge is illegitimate; a specific aesthetic stance brings its own problems; the diversity of aesthetic response cannot be used for scientific purposes; and, lastly, aesthetic ambivalence cannot produce scientific certainty (*210*, 216-224). I will treat these individual points collectively in what is, admittedly, a very general response. During the course of this dissertation, it has been seen that the role of aesthetics in early Romantic science is deeply embroiled in the issues concerning the reliability and the improvement of the inquirer's own aesthetic capabilities. The employment of ideal types, for instance, points both to the endless diversity of nature's purposiveness, and to man's response; equally, it points to the experiential and epistemological base of the Romantics' aesthetics and notions of productivity. The key characteristic of early Romantic inquiry lies in the mediating role of the subject in the various forms of productivity and knowledge formation. In this context, aesthetics are not so much a specific activity as part of a whole approach to productivity. It is in these areas that one may find a degree of compatibility with Jardine's own responses; some response in terms of early Romantic thought itself can thereby be made to the objections raised against aesthetics in a scientific context.

How practicable is the early Romantic methodology? Although it, to some extent, fulfills the requirements of Jardine's rationales it is, admittedly, somewhat general. Add to this the metaphysical assumptions contained in the notion of continuity and the early Romantic project appears, at first sight, too bound up in its own time, and too heavily loaded with past traditions, which cannot easily be hauled in and converted to a less metaphysical programme. This problem of dissociation can perhaps be resolved by showing how past traditions and precedents are handed down and altered in a continuum of knowledge. Such a form of interpreting knowledge argues, incidentally, also against Foucault's notion of the "episteme". If one unravels the unifying of practice from its higher metaphysical levels down to more pragmatic ones, it can be seen how the term "practice" holds for a variety of levels of thought. Beginning with high level theory: the idea of unifying man's consciousness with the purposiveness of nature (or, as Schelling puts this, "Die Natur soll der sichtbare Geist, der Geist die unsichtbare Natur seyn" (*106*, 56)) is, obviously, highly metaphysical. At almost the same level, but slightly beneath this, we then come to the idea that Nature's figures have some correspondence and "Sympathie" with man's own figures of the productive imagination. Again this is highly metaphysical, though more concrete than the earlier idea. We then descend to the idea of a "phenomenal" calculus, arguably a crossover point between the more and the less metaphysical. After this, we see how the diagrams of such a "calculus" may assist discovery. Finally, we can also see how the individual case study helps activate the beginnings of such a form of inquiry. Thus, descending the ladder from high-level to lower-level understandings of practice, we can see both the versatility and the continuity of notions such as productivity and "experiment". One can thereby trace the paths from metaphysical to less metaphysical assumptions. This, in its turn, allows one usefully to mediate past and present methodologies. This entire descent can therefore be seen as a "cascade" rushing through various levels of epistemology.

This sketch of a descending path serves to show that the early Romantic programme can, perhaps, be interpreted at a level which makes it comprehensible in terms of a less metaphysically oriented discourse. Moreover, if one takes two factors into account it becomes, I would like to propose tentatively, a practicable methodology. The first factor is the role of the subject, as expressed in the idea of individual natural productivity. For a variety of reasons, the re-introduction of the subject overcomes some of postmodernism's major quandaries, such as have already been referred to, notably the "Experimenter's Regress" and the linguistic regress. The second factor lies in the role of the details of contemporary practices and doctrines. I will make some reference to these in the context of Ritter's work on galvanism. Once one supplies early Romantic methodology with the details of local issues, its methodological basis - a general theory of productivity revolving around the issues of experiential knowledge and the deployment of a "phenomenal" calculus - can, perhaps, be seen as practicable. To deal with the first point, let us briefly rehearse the key points in Novalis's rhetoric of experiment, so as to delineate once more how he makes use of the subject in inquiry. His notion of experiment is based on the notion of re-experiencing experience in a productive manner; in an interdisciplinary fashion, a key phenomenon is selected and elevated to the level of practical knowledge. Such a phenomenon is then employed in further inquiry, which operates according to the scheme of a "phenomenal" calculus as a concrete, symbolic form of notation. This pattern of thought was traced in Ritter's work. If one adds the further details relating to galvanic inquiry necessary for calibration, one can see how the methodology, if supported by its context, has some potential as a model for consensus attainment. As such, it is most applicable to the context of its own time; but the methodology also has aspects which are not explicitly metaphysical, and which give it some degree of applicability as a model for inquiry today. Looking at Ritter's work in the light of precedents and standards, one can note a variety of factors in his method which enhance the way he attains consensus in the galvanic debate. Ritter used the commonly employed apparatus for galvanic experimentation, and also the then current form of an "electroscope", the muscle of the frog's leg. He expanded on Humboldt's investigation of chemical substances, and explored the notion of a series of conductors with differing galvanic "effects"; he worked within the realm of Volta's galvanic laws, accepting Volta's notion of two classes of conductors; and he attempted to place contemporary debate over animal and physical electricity under a single common denominator, the "constant galvanic force". One could go further, beyond issues of instrumentation, materials and theory, to consider institutional factors, such as the publishing of experimental findings in accepted journals, or the reading of papers in scientific institutions. One could include, too, the public performance of galvanic experiments. Of course, Ritter's understanding of galvanism was actually overtaken by Volta's invention of the battery in 1800; thus, one can only speak of his paths towards consensus in 1798. None the less, in a wider perspective, Ritter's ideas on a galvanic circuit and on electrochemistry are of fundamental importance in the quest for consensus in the field of electrochemistry.

It must be stressed that this is a highly abbreviated account of the issues concerning galvanism and is meant only to elucidate the idea of consensus attainment. However, even given the brevity of this account, one can see that in Ritter's work of 1798, specific precedents and standards are accounted for, enabling some degree of consensus. We obtain, too, a picture of consensus in early Romantic inquiry from the manner in which Ritter and Novalis accord over methodological issues. By putting these factors together, namely Ritter's reacting to the issues of galvanic inquiry in 1798 and the shared ideas of early Romantic methodology in Ritter and Novalis, we can, I think, more readily understand that the early Romantic notion of inquiry can be seen as practicable at a less metaphysical level than is often assumed. Goethe's and Humboldt's notion of inquiry can, of course, also be interpreted in a similar, less metaphysical manner, when the issues concerning practical knowledge, such as symbolic notation, and the details of the contemporary scientific debate, are brought into play. It is on this less metaphysical interpretation that the early Romantic form of inquiry and its methodology is, to some degree, relevant to science today. The crux of the matter, I would argue, rests upon the way this methodology can be interpreted as a form of practical knowledge, and upon the way it attains meaning when applied to the details of a particular area of inquiry. When so applied, as in the case of Ritter, the early Romantic notion of inquiry can be seen to be no longer general, but actually quite specific. In the final instance, however, it must be recognized that this is only a model of inquiry, and practicable only at the level of historical reflection: as Jardine says, it is up to reflective scientists themselves today to develop their own approach to aesthetics (*210*, 224).

What the early Romantic notion of inquiry might offer modern scientists, then, is a form of ontological and epistemological security concerning the value of scientific activities as truth. As Jardine puts this idea when referring to the possible role of aesthetics in inquiry, it offers the scientist "a modicum of reality" and "truth" for their inquiries (*210*, 224). In that sense, a stance such as that of the early Romantics, supports current practice.

In a broader perspective, I would suggest that one could approach early Romantic inquiry in terms of the history of the practice of ideas. The latter may be understood as the history of individually realized methodologies. In this manner, one can see epistemological cascades running through the history of inquiry. These form a continuum. Jardine himself argues for the role of local doctrines and practices for an understanding of inquiry and this, it goes without saying, shows a highly reflective approach to the idea that science moves progressively towards truth. For that reason, Jardine's view will probably commend itself more than scientific absolutism. The role of the individual in inquiry, as developed in early Romantic science (the use of the subject and the individual's realization of methodology), adds a further dimension to Jardine's emphasis on local issues: the role of the individual scientist, and not theory alone is stressed. If one envisages such an epistemological cascade, one can also see the way "local" ideas are developed throughout the continuum of inquiry: importantly, this continuum is not just a history of ideas, it is the history of the practice of ideas. Thus one sees in Novalis aspects of Neoplatonism, German Idealism, and the modern experimental tradition. These, in turn, can be grasped and modernized in terms of postmodernism, tacit knowledge, and the renewed interest today in practical knowledge. Such a concept of the history of the practice of ideas - with both of its aspects: the one that illustrates traditions at play within a particular epoch, and the other that illustrates the development of traditions within the continuum of inquiry - is, I think, of use for understanding how consensus may be attained. In fact, such an approach can be found exemplified in celebrated studies in the history of ideas, which can unproblematically be re-read as studies in the history of the practice of ideas: a key example of such studies may be found in the work of Frances Yates.

### *2.2. Literature and science: the plurality of discourses and perspectives on a common intellectual field.*

This dissertation's interest in the unifying of practice fits into the current climate of intellectual history, for both literary theory and the history of science are concerned with the issues of practice. The epistemological value of "experiment" particularly suits current views on the role of "performance" in knowledge formation, of which Elinor Shaffer remarks:

> Performance is being linked to traditional skills and to moral knowledge and even to notions of practical wisdom by the thinkers and actors strongly opposed to the theoretical movements of structural linguistics and deconstruction which created this opportunity (*282*, xviii).

Practical knowledge and "rigorous" aesthetics are major themes of this dissertation, and help to position it in the current debate over literature and science. In studying practical knowledge, or natural philosophical productivity, the dissertation has taken a step back into areas of knowledge common to both literature and science. A step back has also been taken back into a common context, but this is not a social framework: it is a common intellectual framework. This area can be understood as a common cultural field or cultural discourse (*281*, xxiii-xiv). Yet what has been offered is not so much a study of increasing and decreasing proximities of discourses; instead, the emphasis has lain on illustrating a common epistemological or intellectual realm. Particularly when dealing with the history of science I had to revert to the hybrid sounding term of "active intellectualism" - so as to underline my intellectualist stance, which is opposed to the idea of knowledge as a social construct alone - but the issues of practical knowledge allow one perhaps to talk more naturally of "unifying practice". Thus, the major theme of this dissertation was the idea of productivity and practice, and the notion that aesthetics are part of a broader form of knowledge. "Experiment" is a term pointing to productivity in general, referring to both the arts and science, and their unity in that realm. I have attempted once to express the idea of productivity by speaking of an "experimental", symbolic use of language. This was done to explore possible realms which emphasize the bond between the arts and the sciences.[1] A thinker such as Toulmin, who deals with practical knowledge, treats aspects of the concerns of this work. My examination of an individual's own attainment of practical knowledge, be it in the concrete ideal types of a symbolic notation, or in the interdisciplinarity of a case study where theory is relativized and pulled together in a new form, can, perhaps, be understood as developing Toulmin's views. A thinker whose work has a profound meaning for the path taken in this dissertation is Frances Yates. In her work, notably on Lull, lie the seeds for the idea of a "phenomenal" calculus and the use of the imagination in notation. Finally, Adler's work on Goethe represents the type of in-depth study that is suggested by the notion of the history of the practice of ideas. His book was always a model for the interpenetrative approach to issues of the arts and sciences undertaken in this dissertation. Following such studies as these, I have throughout attempted to show the very cognitive value of the subject matter in hand, and, consequently, of the historian's interpretations, too.

Thus it is that this dissertation's approach to literature and science is not so much uni-directional, but can perhaps be seen as an attempt to propose epistemological premises for both literature and the sciences. Given this attempt, the dissertation does not, in essence, argue for dominance of either the arts or the sciences, even given its central concern for Romantic science. My main concern is cognitive gain, and although literature is not explicitly treated, this thesis has illustrated a type of thought that may be seen as common to both the arts and the sciences.

Finally, I wish to reflect once more, and briefly, on the possible scope of the history of the practice of ideas and epistemological cascades. The foregoing argument has illustrated these notions in Ritter's work, and, in doing so, has traced aesthetic elements in his science. I will now repeat the results gained in terms of the history of the practice of ideas so as to make this latter term more cogent. The units of Ritter's work which form an epistemological cascade are: the series of experiments themselves, the visualization of the experiments in diagrams, and, arguably his use of language itself, for in his *Beweis* he gradually arrives at his theory in a non-linear form of argument. Finally, if we take Novalis's reception of Ritter into account, which accords with all the instances here mentioned, we also encounter the explicit meeting-point of a variety of traditions of thought: as mentioned, Neoplatonism, German Idealism, and the modern experimental tradition. All of these forms of practical knowledge, too, form an epistemological cascade. As these are aspects of knowledge formation which could be used in conjunction with the socially-oriented notion of knowledge formation found in interest and network theory, in this manner, the history of the practice of ideas (or of practical knowledge) could be seen as an epistemological parallel to the socially-oriented studies in the history of science. In addition, and more of interest to literature and science studies, one could extend the idea of epistemological cascades to literary texts themselves, to observe in them the interplay between literature and science at the level of the practical knowledge. This approach can be seen, for instance, in the work of Elizabeth Wilkinson on Goethe's *Tasso* and the concept of "Steigerung"; in which she reciprocally illuminates a literary text and a scientific theory (*293a*). The full scope of the history of the practice of ideas is thus far more than that illustrated in this dissertation.

# Notes

## Introduction

1. A study of the Register volume (*N*, *5*) alone reveals the fact that Novalis uses "experiment" almost exclusively from his time at Freiberg onwards, and scarcely at all for example in the years 1795-6 during his *Fichte Studien.*

2. See Ospovat, 'Romanticism and German Geology' (*251*), who speaks of the width and depth of Werner's interests, and how he would have appealed to Romantics through his historical approach to knowledge.

3. He had read of Brown through Röschlaub's work *Untersuchungen über Pathogenie* (1798) (*101*).

4. Gary Handwerker still finds the often supposed subjectivity and sceptical relativism of Romantic irony prevalent in a recent volume of the International Comparative Literature Association, *Romantic irony* (ed., Frederick Garber, Budapest, Akadémiai Kiadó, 1988). The Romantic concern for productivity is important for an understanding of Romantic irony. In a thinker such as Novalis irony can be linked to epistemology, ontology and history. Romantic irony cannot, in the case of Novalis, be put down as "capricious aestheticism" as Kierkegaard viewed it (*183*, 282).

5. See e.g.: Neubauer (1985), (*246*); Elinor Shaffer (1985), (*278*),; Beer (1989), (*139*, 18-24), ; Rousseau (1989), (*266*, 48-54); Weininger (1989), (*131*, xiii-xxiii); Dear (1991), (*160*, 1-9); Elinor Shaffer (1991), (*281*, xv-xxix), (1992), (*282*, xv-xxvi).

6. For related points of view, see Elinor Shaffer, (*281*, xxi); Weininger, (*131*, xxi-xxii).

7. Elinor Shaffer uses Mary Hesse and D.A. Schon as examples (*282*, xvi). Amrine and Cohen seem to make a related point: "One fundamental question has to do with the epistemic value of the metaphor and literature generally: good work on the former has been done by Mary Hesse among others ..." (*131*, x). See also Weininger (*131*, xvi).

8. From a strictly literary perspective Goethe is not seen as a Romantic. However, I adopt the European convention of treating him with the Romantics, notwithstanding the gulf, because of the many important similarities.

9. For a discussion of Frank's work see Henriette Herwig (*195*, 95-109).

10. See, for example: Mähl (*331*), Jacobs (*207*), Reis (*343*), Saul (*345*; *346*).

11. The term "history" can only cautiously be used here, since Schelling views ethics as the proper area of history. See Jacobs, (*207*). This is a part of Romantic thought not dealt with in this work due its prime concern for clarifying Romantic notions of knowledge formation.

12. See Meyer (*242*, 146-148), for Schelling's reasoning behind his notion that man can gain *a priori* knowledge of Nature. Meyer points to Schelling's prerequisite for his system of natural philosophy, namely that "das Ganze der Erscheinungen nicht bloß Produkt, sondern zugleich produktiv ist" (ibid., 147). See also Heckmann (*189*, 297, 334). Heckmann stresses the difference between empiricism and Schelling's natural philosophy. He tends to relativize the importance of experience in Schelling's natural philosophy, remarking that Schelling sees experience as necessary only for the "context of discovery", but not for the "context of justification" (ibid, 334).
13. See Frank's remarks discussed below, p. 131f. Frank, importantly, comments on the role of the absolute in Schelling's philosophy. He states that Schelling views the finite as part of the absolute, and that Schelling's concern with the finite is necessarily part of his attempt to construct the absolute. In this way, one can see how Schelling's attempt to construct the totality of experience is essentially a process stretching the notion of experiential knowledge to its limits.
14. For an analysis of Kant's aesthetic and teleological judgement see Podro (*255*), chapter two.
15. See Halliburton, (*182*, 92); and, further, Hannah Arendt (*134*, 40-41).
16. Cited from Jonsen and Toulmin, (*211*, 66); Aristotle, *Nichomachean Ethics*, VI. viii.9, 1142a.
17. Cited from Jonsen and Toulmin, (*211*, 66); Aristotle, *Nichomachean Ethics*, VI. viii.9, 1142a. Jonsen and Toulmin add in a footnote: "This condensed passage from the *Ethics* has caused translators and scholars difficulty, perhaps because they read the analogy between ethical and mathematical "perception" as intended to be closer than Aristotle meant it to be. For, he added, *phronesis* in Ethics is different in kind (*allo eidos*) not just from sense perception but from mathematical perception also; and in this way he took back some implications of what he had said just previously. Our reading takes the word *eschaton* as covering what we earlier called 'a paradigmatic case'" (*211*, 360, fn. 34).
18. See Novalis, (*N*, 3, 179, 441, 445, 469).
19. The passage Janik refers to in Wittgenstein is: (*296*), part 1, § 201.
20. See Kuhn, (*224*), chapter 11.
21. See Novalis, (*N*, 3, 183, 185, 72, 74). These points are all discussed in chapter three of this thesis.
22. See the comments given above in footnote 12.
23. Schelling had, of course, written some poetry. See e.g. Sue Morgan (*244*, 34-35), and Frank (*170*, 102-103).
24. See Schmid (*348*, 52) and Werner (*126*, Vorbericht, xi, and vol.2, 254 ff).
25. The institutional effect of Werner on geology is well known. See e.g. Guntau (*181*, 33); Laudan (*231*, 102-112).

26. This work, as must often be stressed, treats the early period of Romanticism and the genesis of Romantic ideas: similarities of doctrine in Romantic thinkers are traced, but always with the notion of practice in view.

27. See e.g. Koch (*219*, 49-74).

28. For an overview of Humboldt's geographical thought, see Margarita Bowen (*146*, 210-259).

29. Rachel Laudan does refer briefly to Humboldt's "ingenious pasigraphic scheme" of 1823 (*231*, 162-163).

30. See Hölder (*200*, 40) for a re-drawn version of one of Voigt's sections in his 1782 work, *Mineralogischen Reisen* (*120*).

31. For an example of Trebra's stratigraphic diagrams, see (*118*, 231, Tafel 2).

32. Werner's influence on Humboldt has been traced by Albury and Oldroyd (*130*), and Baumgärtel (*135*), but not in the present terms of this work as a theory of practice. Albury and Oldroyd, for example, discuss the influence of Werner's geognosy on Humboldt's idea of rock formation (*130*, 201-206).

33. See also Sepper (*276*, 70); Kümmerl (*226*, 209).

34. For a related view of language in this century see also Halliburtons's remarks on Justus Buchler's notion of the "proceiver" (*182*, 91-92; *148*, 4, 47, 48).

35. Even though critics such as Schmid (*348*, 14-28), Ospovat and Cardinal (*251*; *307*) have contributed to a better understanding of Werner - and in particular Ospovat -, the issues of tacit knowledge have not, as far as I can tell, been applied to the context of Werner's work.

36. Examples of such works are: Lukács, (1920), (*328*); Köhn (1969), (*324*); Jacobs (1972), (*321*). See further Uerlings's overview on the topic: Uerlings, (*354*, 453).

37. See Beck (1976), (*305*) and Stadler (1981), (*351*). See too Uerlings's remarks (*354*, 453-4).

38. Major works treating sciences other than medicine are those of Kapitza (1968), (*322*); Clark (1975), (*308*); Neubauer (1978), (*339*); Mahoney (1980), (*332*); Hansen (1993), (*319*). Minor works, but of significance for Novalis scholarship are, Molnar (1973), (*333*); Wetzels (1973), (*356*); Löffler (1978), (*326*); Burwick (1986), (*306*); Stadler (1989), (*352*).

39. Karin Clark's work of 1975, 'Das Bild des Wassers bei Novalis im Spiegel seiner naturwissenschaftlichen und philosophischen Fragmente' (*308*), traces the symbolism of water in Novalis's thought and works. It is shown how, in contrast to the views of previous Novalis criticism, Novalis did not believe that water was an element. Instead Novalis employs water as a symbol for his philosophy of "fluidity". Karin Clark studies Novalis's fragments related to the subject of water in detail and goes on to give examples of Novalis's fluid symbolism in his literary works.

40. An exception here is the work of Lohse (*327*), as Uerlings points out (*354*, 113).

41. Frank's work also makes a deconstructionist analysis of Novalis such as Kuzniar's (*325*) questionable. A deconstructionist view-point does not account for Novalis's notion of language, since the latter cannot properly be described as autonomous or entirely temporal.

42. See e.g. Mähl (*330*, 199).

43. As discussed, Uerlings's view of "narrative Konstruktion" leads to his interpretation of early Romantic utopia as "narrative Konstruktion einer erhofften Tendenz" (*354*, 609). This is a subtle approach for emphasizing the seriousness and productive aspects of Novalis's idea of utopia. In section 1 of the introduction ways were pointed out as to how Uerling's notion could be applied to the history of science and how natural philosophy and "experiment" can, arguably, put a new emphasis on Novalis's views on utopia.

44. Gaier's work is composed in such a fashion that makes it difficult to display the way in which Novalis received and combined various disciplinary approaches. Gaier's work is split into two halves: the first deals in great detail with Novalis's notion of knowledge mostly within his own terms (and the literary ramifications of this). The second half looks at a tradition of thinkers, such as Plotinos, Becher, Andreae, Fludd, Bacon, Fichte, Hemsterhuis and Herder, who, in Gaier's view, fit into the tradition of "Konstruktion" that Novalis espouses. While this history of the tradition of "Konstruktion" is illuminating, Gaier leaves much historiographic work still in need of completion to see just how Novalis received these thinkers (if at all in some cases) in his own work.

45. Novalis notes down a considerable amount of material from Lambert's works. These jottings fall into three major categories: knowledge formation or philosophical methodology (*N*, 3, 130-132), scientific experimental method (*N*, 3, 132-133) and language theory (*N*, 3, 133-134). Lambert's remarks on scientific method are standard (see *N*, 3, 132) and Novalis's sources for his own notion of "experiment" lie equally in Plotinos, Herder, and the philosophers of German Idealism, and even more so in the scientific practice of Werner, Goethe and Ritter.

46. For a consideration of Frank's intepretation of "ordo inversus" see below, p.374.

47. A further work deserving mention, while not covering the sciences, is White's 'Novalis's *Heinrich von Ofterdingen* and the Aesthetics of 'Offenbarung'' (*357*), which treats Novalis's understanding of revelation. White describes how Novalis argues that old dogma, for example religious knowledge, should not be dogmatically accepted, but has to be re-experienced through mediation (*357* ,102-104). White remarks, for instance: "The real point is that, unlike so many of his contemporaries, Novalis does not have a fixed philosophy of revelation; his relationship to the issue is much more experimental than this" (*357*, 94). As White further comments, the revelation has to be completed by the actual reader of Novalis's works (*357*, 109). Here White's thesis touches upon Novalis's concept of "experiment", as a concrete form of knowledge (as opposed to a conceptual one). Indeed, the "experimental" processes of religious experience, or of reading Novalis's texts, for they are fragments which have to be completed by the reader, are exemplary of

6. Yates describes the somewhat gruesome origins of Simonides' art. He was alerted to the usefulness of memory when at a banquet he memorized where all the guests were sitting; the roof of the hall subsequently collapsed, leaving only mangled, unrecognizable corpses. He then employed his art to ascertain the identities of the corpses, much to the relief of the concerned relatives of the dead (*299*, 1-2).

7. Symptomatic of Moser's stance is his one brief footnote which refers to the Romantics' too aestheticized view of science (*245*, 78-79, fn.22).

8. Yates also remarks of Bacon when speaking of John Dee, placing Bacon in the tradition of Hermetic Neoplatonism and their use of magic symbolism: "Published in 1564, with a dedication to the Emperor Maximilian II, Dee's *Monas hieroglyphica* describes a sign composed of the signs for the seven planets and of the zodiac sign Aries, in which he believed he had found a unifying statement that included the whole universe. The commentary on the *Monas* combines alchemical, mathematical, and Cabalistic modes of thought, and was probably expressive for Dee of ascent through all three worlds described by Agrippa - the elemental, the celestial, the supercelestial - to the First Cause or the One. Dee always regarded his *Monas hieroglyphica* as his supreme achievement. For this man of extraordinary genius who lived within the categories and magical presuppositions of the Renaissance world of Hermetic Neoplatonism, it was presumably an expression in what Francis Bacon or Leibniz might have called 'real characters' - signs believed to be in actual contact with reality - of some profound unifying experience" (*300*, 54).

9. Crosland shows how alchemical symbols were taken up and developed by Geoffroy and Bergman: symbolism was very much incorporated into the affinity tables of the eighteenth century (*158*, 228-244). The tables expanded quite significantly: Geoffroy's table of affinity of 1718 had sixteen columns, Bergman's table of 1775 had already fifty-nine columns. Adler comments on the significance of the affinity tables for the chemistry of the time, arguing that they were representative, and part of the ambitious goals of chemical inquiry: "Hinter ihnen stand der Gedanke, eine vollkommene Tafel aller 'Verwandschaften' würde die Beschaffenheit der Materie und ihre Grundkräfte erklären" (*129*, 58). Adler shows how the main notion behind the tables, that of chemical affinity, was a point of great concern for major chemists and scientists such as Macquer (1718-1784), Cullen (1710-1790), Black (1728-1799) and Berthollet (1754-1822), and how with the arrival of early electrochemical theory the tradition of the affinity tables then died out (129, 57-73). But, as the discussion of Ritter's use of diagrams in chapter four shows (see below, chapter 4, section 9), the affinity tables, at a deeper level, provide an important precedent for Ritter's particular type of diagram. Bergman's affinity tables, like Ritter's diagrams, were schematic models, and they also can be seen as a kind of "natural" or "phenomenal" calculus.

10. Novalis's meaning of "Gefühl" is later discussed with reference to his comments on Plotinos and a method of inquiry (see below, chapter two, section 7).

Novalis's entire attitude to knowledge. For Novalis believed in a fundamental stock of metaphysics or knowledge, which ran throughout the ages, and that was constantly re-enacted and expanded upon: individuals always both allude to and fortify tradition, and in this way both experience and "experiment" with knowledge.

## Chapter One

1. Lakatos differentiates between a psychology and a psychologism of induction: "I want to distinguish between psychological, plainly second-world concepts, like 'belief', and psychologistic concepts like 'rational belief' in the sense of 'belief of a clear mind'. While psychology may be defined as the theory of the mind, psychologism is the theory of a 'healthy', 'normal', 'clear', 'ideal', 'empty', 'purged', 'unbiased', 'objective', 'rational', or 'scientific mind'" (*227*, 208, fn.5).
2. See Lakatos (*227*, 198-201) on justificationism, and (*227*, 221) for his explanation of the concomitant Humean dogmatism spurred on by Newton's standards and achievements: "Scientific scepticism, defeated by Newton, degenerated into Humean psychologism and joined forces with dogmatism: human reason may not give assent to Newton, but human nature must. But then the study of (unchanging, external, universal) human nature will lead us to a theory of (monolithic) 'healthy' belief."
3. Koyré remarks on the source of the term *experimentum crucis*: "Professor H.W.Turnbull (*Correspondence*, I, 104) points out that the expression *experimentum crucis* is a misquotation by Hooke (*Micrographia*, p.54) of the Baconian *instantia crucis*. Thus, Newton in using it 'is reminiscing from his reading of Hooke'" (*220*, 42; 69).
4. Lohne puts Hooke's use of the term *experimentum crucis* into its full context of Hooke's optical investigations, and the term's meaning is clearly that of a key piece of evidential argument, setting the path for future inquiry. Lohne cites the following from Hooke: "This Experiment [generating colours by thin plates] therefore will prove such a one as our thrice excellent Verulama calls *Experimentum Crucis*, serving as a Guide or Land-mark, by which to direct our course in the search after the true cause of Colours. Affording us this particular negative Information, that for the production of Colours there is not necessary either a great refraction, as in the Prisme; or Secondly, a determination of Light and shadow, such as is both in the Prisme and Glass-ball" (*236*, 179; *53*, 54).
5. An examination of Novalis's most important references to "experiment" in the list in Appendix A shows that the notion of "test" is not always in his mind when he uses the term.

11. The original source is Diogenes Laertius, who, in his *De vitis philosophorum*, wrote on the life of Diogenes of Sinope. The "walking" is one of the many anecdotes described: "Ähnlich machte er's mit dem, der behauptete, es gebe keine Bewegung: er stand auf und spazierte hin und her" (*23*, 1, 313; *24*, 2, 263-4 (6, 39).

12. Fichte uses the instance of Diogenes to argue how the act of the self automatically argues for its freedom, thus in the same way that Fichte argues that knowledge is an activity, so too, in his view, did Diogenes show that motion was continuous by showing it as a fundamental activity: "Diogenes ging, um vor der Hand sich selbst - denn die verirrte Speculation war dadurch freilich noch nicht in ihre Grenze zurückgewiesen - die geläugnete Möglichkeit der Bewegung zu beweisen. Eben so - wollt ihr jemand die Freiheit wegvernünfteln, und gelingt es euch wirklich durch eure Scheingründe Zweifel über die in Anspruch genommene Sache zu erregen, so demonstrirt er sie auf der Stelle durch Realisirung eines Products, das er nur von seinem eigenen freien Handeln ableiten kann" (*28*, I, 3, 177).

## Chapter Two

1. There is an abundance of references in Novalis's writings to the "moral organ" or man's "organ" in a higher sense. See: *N*, 2, 365ff, 371 ,375, 562, 577; 3, 264, 361, 385, 403, 466, 513, 517, 520, 563, 570.

2. A detailed analysis of Novalis's idea of the Golden Age in relation to his notions of "Wortfigur" and "Figurwort" is given above in chapter four, section ten.

3. In 1797 Novalis was just beginning to develop his scientific interests in preparation for his studies at Freiberg, so he would have had an interest in Kant's scientific views; indeed, in the *Kant- und Eschenmayer-Studien* (*N*, 2, 379-394), Novalis made some notes on Kant's *Metaphysische Anfangsgründe der Naturwissenschaft* (*N*, 2, 392-394); but his scientific outlook had already been set by his reading of Hemsterhuis. He was searching for a Neoplatonic outlook which he could not find in Kant. Kant's dynamist view point would naturally have interested him, as his reading of Eschenmayer (1768-1852), another dynamist, in the *Kant- und Eschenmayer-Studien*, shows. Yet again, his concentration was not really on Kant or on Eschenmayer, but once more on Hemsterhuis, since Kant's dynamism, as interpreted and expanded by Eschenmayer, showed the essential forces espoused in Hemsterhuis's works, as Mähl points out: "Die von Eschenmayer als ursprünglich angenommenen Grundkräfte der Materie sind aber nichts anders als der von Hemsterhuis hervorgehobene Antagonismus von Attraktions- und Zentrifugalkraft, der als Grundgesetz des

körperlichen wie des seelisch-geistigen Lebens erklärt worden war und der Novalis als Vorstoß zu einer "symbolischen" Behandlung der Physik besonders angezogen hatte" (*N*, 2, 332). Four points govern Novalis's view of the sciences at this time when he was reading Kant and Eschenmayer. Firstly, his reading of the sciences is ruled by Hemsterhuis's Neoplatonic forces; and secondly, in 1797 Novalis already has the aim of tackling the sciences symbolically in a type of "Combinatorik" which he actually developed later. Thirdly, his interests in organization are already developing here as well, since he mentions Brown in the *Kant- und Eschenmayer-Studien*. When Eschenmayer speaks of motion as a principle of matter, Novalis makes a cross reference to Brown and excitability theory. Novalis notes from Eschenmayer, "Beweglichkeit ist die Grundbestimmung der Mat[erie]", and then comments "/Vid.Brown - Erregbarkeit./" (*N*, 2, 385). Later, in 1798, Novalis speculates that excitability theory could be applied to physics (see above, chapter three, section 3.3). Fourthly, as Mähl has pointed out (*N*, 2, 332), Novalis turned to Eschenmayer, not only because Eschenmayer dealt with the subject of dynamism and Kant's natural philosophy, but also for the reason that Eschenmayer dealt with Fichte, for Eschenmayer was attempting to unite the Fichtian principles of the *Wissenschaftslehre* with a "Naturphilosophie". Naturally, Novalis had in interest in seeing how Fichte's notions could be applied to the sciences. Important as this sounds, one must again bear in mind that Novalis's fundamentally Neoplatonic outlook influenced his understanding of Fichte as well (see sections 1.7 and 1.8 of this chapter).

4. Novalis by no means outrightly dismissed Kant's thought, but certainly distanced himself from Kant; the following remark shows that he was highly aware of Kant's achievements, but at the same time took an ironic view of the philosopher: "Die ganze Kantische Methode - die ganze Kantische Art zu philosophiren ist einseitig - und man könnte sie vielleicht nicht mit Unrecht Scholasticism nennen. Freylich ist sie ein Maximum in ihrer Art - eins der merckwürdigsten Phaenomene des menschlichen Geistes" (*N*, 2, 392).

5. Novalis takes a different approach to the major problem that Kant was trying to solve, i.e. the possibility of *a priori* knowledge in theoretical reason. Since Novalis believed in a universal "sympathy" of things and that ideas and knowledge were part of experience and the make-up of the world, the general Humean problem of experience and knowledge, i.e. that knowledge can come only from sense experience, was side-stepped. For, to Novalis, since knowledge was experience, there was no question of theoretical knowledge having to be "experience free" since he thinks always in terms of an experiential whole of knowledge for aesthetics and for the sciences. Secondly, the Humean problem of predictability could, in Novalis's view, be mitigated through the issues of actual scientific practice. As will be argued, the "phenomenal" calculus of Ritter's diagrams assist in theory building and in the attainment of "predictability". Kant, on the other hand, was deeply impressed by Newtonian mechanics, and held that sound theory in its very predictiveness argued for a deductive approach to theory and not Humean induction. Losee comments on Kant in this way:

"Immanuel Kant professed to be greatly disturbed by Hume's analysis of causation. Kant conceded that if the form and content of scientific laws wholly derive from sense experience, as Hume had urged, then there is no escape from Hume's conclusion. However, Kant was unwilling to grant Hume's premiss. Against Hume, he argued that although all empirical knowledge 'arises from' sense impressions, it is not the case that all such knowledge is 'given in' these impressions ... According to Kant, Hume's inadequate theory of knowledge was associated with an equally inadequate theory of science. Kant believed that Hume was preoccupied with inductive generalization. Kant held that this emphasis draws attention from the most important feature of science - the attempt to achieve a systematic organization of knowledge. Kant was profoundly impressed by the scope and power of Euclidean geometry and Newtonian mechanics and he attributed this scope and power to the deductive structure of these disciplines ... Kant formulated criteria of acceptability which reflect this emphasis on the systematic organization of experience. With respect to individual empirical laws, Kant downplayed instance-confirmation, in which deductive consequences of laws are seen to be in agreement with observations. He believed the incorporation of laws into deductive systems to be more important. Kant would hold, for instance, that although Kepler's laws do gain support from data on planetary motions, they gain further, and more important, support from their 'incorporation' into Newton's theory of mechanics.

With respect to theories, Kant cited as criteria of acceptability predictive power and testability. He noted that successful theories bind together empirical laws by means of reference to new entities or relations. Implicit in this systematization is the possibility of extending the interpretation of these entities or relations to further regions of experience. Kant drew attention to the fertility of scientific theories. He suggested that those theories are most acceptable which extend our knowledge of relations among phenomena" (*237*, 107-108).

6. The essay on Goethe was written between 25 August and 9 September of 1798 (*N*, 2, 519).

7. The notion of "holy physics" is discussed more fully below in relation to Plotinos (see section 1.7 of this chapter).

8. See, for example, Faust :"Auf einmal seh' ich Rat / Und schreibe getrost: Im Anfang war die Tat!" (*38*, 3, 44, line 1237).

9. There is a further aspect to Goethe's and Novalis's notion of the rhetoric of "experiment". In their concept of "experiment" there is link between dialectics and the idea of a series of phenomena with its mathematical and Neoplatonic connotations, as will be shown with reference to Plotinos. The notion of the synthesis of the "higher experience" and the notion of a row of experiments link both patterns of thought together. See section 1.7 of this chapter.

10. In the following remark Novalis further reveals his broad notion of a concrete "Calcül" of discovery. In his view, critical philosophy is also a "calculus" since it attempts to set up a model for future knowledge and inquiry. Fichte's *Wissenschaftslehre* was, to Novalis, a concrete form of

"calculus" with predictive potential, it too was not plain theorizing, but discovering: "(Alle Phil[osophie] oder W[issenschaft] d[er] W[issenschaft] ist Kritik.) (D[ie] Idee v[on] Phil[osophie] ist ein Schema d[er] Zukunft.) (*N*, 3, 439).)

11. See Mähl (*330*, 171-206).

12. Mähl remarks that Novalis is speaking here of a "begleitende Symbolisation" in the sense of Kant's "transzendentales Schema der Einbildungskraft" (*N*, 3, 982), but adapting Kant's notions in view of Plotinos.

13. Mähl comments on Tiedemann's censuring of Plotinos. Quoting from Tiedemann, he remarks that the latter "tadelnd vermerken muß, daß Plotin fortwährend 'aus der intellektuellen Region hinüber in die sinnliche' wechsele, daß er in 'mancherley Bilder, und figürliche Ausdrücke' ausweiche und damit eine 'Hypostasierung abstrakter Begriffe' vortäusche (*N*, 3, 982; *117*, 294, 362, 411).

14. This refers to Novalis's remark, "ob das nicht der rechte Weg ist, die Physik im allgemeinsten Sinn, schlechterdings Symbolisch zu behandeln?" (*N*, 4, 255).

15. In addition, it is of interest to note that even though Novalis had only read of Plotinos through Tiedemann he seems to have hit upon the way Plotinos did, in his own time, work upon a concrete metaphysics that bound empirical and metaphysical ideas together. This can be seen from the significance of Plotinos himself for the history of thought, as understood by Adler: "In der Philosophie Plotins (ca. 205-270) erreichte die 'Sympathie' ihre nächste große Entfaltung und nahm dort eine zentrale Stellung ein. Plotin verwendete 'sympatheia', aber auch andere Wörter wie 'symphonia', 'harmonia' und 'analogia'. Für Plotin ist die aus dem 'Einen' entstandene Welt durch 'Sympathien' vereint. Diese reichen hinab von der 'Idee' durch verschiedene Stufen zur Materie und stellen die Einheit des Alls her. Wie es z.B. in Enneade V, 4, 32 heißt: 'Das Weltall [ist] ein einheitliches Lebewesen, welches alle in ihm befindlichen Lebewesen enthält'; diese ganze 'Alleinheit' steht in einer 'Wirkungsgemeinschaft' oder 'Sympathie'. Plotins Denken bringt wichtige Neuerungen. Darunter: die Erweiterung des physischen Begriffs der Stoa auf Beziehungen zwischen Geist und Materie und seine Erweiterung auf Sehen und Erkenntnis. Wie Bolus behielt Plotin aber auch den magischen Aspekt des Begriffs bei. So konnte die 'Sympathie' in doppelter Form auf die Neuzeit wirken: als empirischer Begriff der Stoa und als Teil eines übergreifenden metaphysichen Systems bei Plotin. In der frühen Neuzeit treten beiden Strömungen vereint auf" (*129*, 39). Adler's source is Karl Keiling (*212*), 'Über die Sympathie bei Plotin', pp.11, 13, 24f., 47f.

16. Mähl draws attention to Novalis's probable source for his view of Socrates in his reading of Hemsterhuis (*N*, 3, 970-971). In his *Lettre sur l'athéisme* Hemsterhuis writes: "Enfin, Socrate, cet être prodigieux, parut; et s'avisa le premier d'entrer tout de bon en lui-même. Il y trouva un monde tout autrement riche que celui que ses organes physiques lui développoient, où on ne voit que

passivement ce qui est produit; tandis que dans l'autre l'homme sent un peu ce que c'est que produire ..." (*50*, 2, 287).

17. Socrates held that ideas were born in debate. See *Der kleine Pauly*: "Aus den zwei bezeichneten Ansätzen (a.Erkenntnis kann im Gespräch 'entbunden' werden; b. der Handwerker praktiziert ein bewährtes Wissen, obschon er dessen 'Theorie' nicht zu formulieren mag) hat Platon die metaphysische Grundlegung allen Wissens postuliert: Alles Werthafte hat Teil an, ja ist geprägt von ideellen Werten, den Ideen. Sicher darf diese Lehre Platons nicht ohne stärkste Einschränkung auf Sokrates zurückprojiziert werden. Ohne Zweifel war Sokrates auf der Suche nach den Werten; sicher war sein Weg durchaus intellektualistisch: Man muß die Werte 'wissen' können, d.h. dieses Wissen muß durch ein prüfendes Gespräch freigesetzt = entbunden werden können" (*162*, 5, 252). See also Taylor (*287*).

18. Novalis elsewhere comments that he should concentrate more on Fichte's notion of the various states of mind, and remarks "Über Fichtes Sehnen etc. - Tendenzen überhaupt" (*N*, 3, 470). Fichte's psychological approach to thought is revealed in the above terms "Trieb" and "Sehnen" (*28*, I, 2, 430-446).)

19. As a consequence, in a broad sense of pathology, all of Novalis's remarks on disease and sin have to be considered with this in mind. Although he may have been himself dogged by illness, this does not mean that he equates man's life entirely with the state of sensibility, illness, sin or with a fallen state. He saw the possibility of man improving his lot, notably by balancing his own constitution. This is a process where irritability plays just as important a role as sensibility. Novalis offers moral possibilities, not "absolute" solutions. Physical sthenia and asthenia have to find a proper balance, just as its mental forms, such as concretization and abstraction. A final goal of the Golden Age is the union of the concrete and the abstract in a state of permanent concrete theorizing, the union of the "Figurenworte" and the "Wortfiguren", or in terms of excitability theory, the union of "Irritabilität" and "Sensibilität". The procedure leading to this potential Golden Age is one of mediation between forces, and between man's capabilities, and, importantly a piecemeal process that accounts for man's limitations, advancing in limited steps ("Höher kanns der Mensch nicht bringen, als daß er einsieht, welches Wissen sich just für seine Stufe paßt - für die Dauer und Constitution seines Lebens" (*N*, 3, 600-1)).

20. One can compare too Volta's highly Newtonian view point in his *Lettres Philosophiques*: "La cause de cette cause est dans le sein de Dieu. Procedes huc, et non ibi amplius" (*122*, 440).

# Chapter Three

1. It has already been remarked on in the introduction that the social aspects of Novalis's thought need to be to be seen in terms of practical knowledge and his own views on utopia. Admittedly, the utopian aspects of Novalis's thought have been set aside to some extent in this work. This was done to direct the reader's attention more clearly at epistemological issues. The main thrust of works on Novalis's idea of utopia, such as Mähl's and Uerlings's fit, in any case, within the epistemological domain of this present work in the sense that they argue for the transcendent mediation of the absolute in man's sphere of knowledge. A significant part of Novalis's utopian notions is found, moreover, in his ideal of natural philosophical productivity - when humans will learn to "plasticize" freely - a topic naturally dealt with in this present work. This is an aspect of Novalis's idea of utopia that falls squarely into the spheres of language, perception, practical knowledge and natural philosophy. The next chapter reveals how the individual inquirer can probably practice Novalis's notion of inquiry. Under the banner of unifying practice a higher level of consensuality than that found discussed in this chapter will be argued for.

2. Nor, on the other hand, and obviously, does Novalis argue for another extreme stance, that of scientific absolutism. On scientific absolutism see Jardine (*209*, 1-9). Jardine provides an overview of historiographical works that have argued against scientific absolutism.

3. See the remarks Sepper makes on Goethe's idea of the phenomenal base of a discipline (above, pp.19-20).

4. This form of inquiry - the employment of a system of symbols to give strategic guidance to the sciences - can be related to Schelling's natural philosophical undertakings. The difference between Novalis and Schelling, however, is that Novalis stresses the idea of productivity. In his natural philosophical works Schelling offers up an array of potent principles and symbols for inquiry. In this manner, his work, like Novalis's, is concerned with supplying strict empirical inquiry with natural philosophical orientation. Naturally for Schelling this takes place on a larger scale than for Novalis, since he provided substantial systems; his works were published and also influenced the scientists of his time. However, what Schelling does not approach so much in detail as Novalis is the methodology needed to employ such natural philosophical principles. Novalis's idea of a programme for natural philosophical productivity is concerned with the application of natural philosophical principles in experimental practice, and the interplay between their use in practice and natural philosophical theory. This theory of application is clearly based around his idea of "phenomenal" calculus. Furthermore, as commented on earlier, it is precisely this aspect of the concerns of the early Romantics, productivity, that Broman overlooks. Broman underlines a related and significant aspect, that of the influence of Romantic natural philosophy on the rise in empirical

description, but the notion of productivity, arguably, takes our awareness of the meaning of early Romantic natural philosophy an important step further. As mentioned, Schelling concentrates more on the productivity involved in evolving and re-aligning strategic initiatives for the natural philosophical principles of the task of reuniting man's consciousness with Nature. The emphasis of Novalis's thought lies more distinctly in the realm of the natural philosophical productivity itself since he speaks directly of his version of its methodology. In the next chapter, however, it will be argued that Novalis and Schelling come closer to one another when Schelling's thought is viewed in terms of unifying practice.

5. Novalis reveals his view of the "soulless" French revolution in *Die Christenheit oder Europa* (*N*, 3, 507-524): "Frankreich verficht einen weltlichen Protestantismus. Sollten auch weltliche Jesuiten nun entstehn, und die Geschichte der letzten Jahrhunderte erneuert werden? Soll die Revolution die französische bleiben, wie die Reformation die Lutherische war? Soll der Protestantismus abermals widernatürlicherweise, als revolutionaire Regierung fixirt werden? Sollen Buchstaben Buchstaben Platz machen? Sucht ihr den Keim des Verderbens auch in der alten Einrichtung, dem alten Geiste? und glaubt euch auf eine bessere Einrichtung, einen bessern Geist zu verstehn? O! daß der Geist der Geister euch erfüllte, und ihr abließet von diesem thörichtem Bestreben die Geschichte und die Menscheit zu modeln, und eure Richtung ihr zu geben. Ist sie nicht selbständig, nicht eigenmächtig, so gut wie unendlich liebenswerth und weissagend? Sie zu studiren, ihr nachzugehn, von ihr zu lernen, mit ihr gleichem Schritt zu halten, gläubig ihren Verheißungen und Winken zu folgen - daran denkt keiner" (*N*, 3, 518).

6. Cited from Partington (*252*, 74).

7. See Partington (*252*, 77).

8. See Partington (*252*, 92).

9. See Partington (*252*, 106,108).

10. E.J.Holmyard, when discussing Paracelsus's views remarks that the alchemical primary bodies were not to be taken literally: "As to material substances, he [*Paracelsus*] considered them to be ultimately composed of the four Aristotelian elements, but immediately of three primary bodies, *tria prima*, namely salt (body), sulphur (soul), and mercury (spirit). He was thus taking over a previously existing modification of the old sulphur-mercury theory of metals, extended so as to apply to all substances, metallic and non-metallic, animal, and vegetable. Salt was the principle of incombustibility and non-volatility; mercury was the principle of fusibility and volatility; and sulphur was the principle in virtue of which substances are inflammable. The theory was not be taken literally; the "sulphur" in wood, for example, is not the same as the "sulphur" in lead, and neither of them is to be conceived as very closely resembling ordinary sulphur. The *tria prima*, or, as they are often known, "hypostatical principles", are indeed nothing more than abstractions of

qualities, and therefore differ essentially in character from the elements of modern chemistry" (*201*, 174).

11. An insight into the symbolic significance of phosphorus is gained by studying the painting by Joseph Wright, An Alchemist, Hennig Brand, Discovers Phosphorus. Wright's oil seems to display a highly charged combination of religious adoration and scientific investigation, and thus the discovery of phosphorus is imbued with a symbolism of a greater truth, both of matter, and of the very essence of inquiry. A copy of the painting is found in Holmyard (*201*, plate 4).

12. My thanks go here to Herr Ulrich Petzold of the Zentralinstitut für die Geschichte der Technik, Technische Universität München, for assisting me in the interpretation of the substance in the text. (Phosphorus was probably too recently discovered to have been fully incorporated into alchemical symbolism.)

13. See the discussion on scientific diagrams in chapter four, section 9, where the diagrams of the alchemists, Bergman, Ritter and Faraday are linked together as part of a tradition of concrete theorizing. Bergman's and Ritter's diagrams in particular can be seen in the light of Novalis's notion of a "phenomenal" calculus, since they operate by drawing the relationships of things together.

14. Peter Kapitza adds, referring to Gehler: "In der Praxis seines Werkes, das die physikalischen wie die chemischen Gesetze behandelt, wird die umfassende Bedeutung des Begriffes Physik am besten deutlich" (*322*, 22).

15. A.N.Scherer remarks also, for example, in 1802, that he was surprised still to find some resistance to the French chemistry in the work of J.F.A.Göttling. The latter's major work of 1794 attacking the antiphlogistians, *Beytrag zur Berichtigung der antiphlogistischen Chemie auf Versuche gegründet* (*42*), was by no means his last word on the subject, for in 1801 he was still continuing his campaign with the article 'Neuere Resultate über das Leuchten des Phosphors in verschiedenen Gasarten' (*43*), and it was on this article that Scherer comments: "Das Leuchten des Phosphors in Stickgas hat schon zu einem bekannten Streit Anlaß gegeben. Man sollte glauben, die Acten wären einmahl abgeschlossen; vielleicht sind sie es auch in den Augen der mehrsten Chemiker. Göttling fährt indeß fort, sich hier von Neuem gegen die Angriffe seiner Gegner zu vertheidigen, und zwar mit Gründen, die aus den Resultaten der Böckmannschen Versuche gezogen sind. Der Leser wird indeß gestehen müssen, daß auch diese nicht hinreichend sind, seine Lehre aufrecht zu erhalten" (*5*, 9, 1802, 27-28). Göttling's nitrogen theory of combustion is discussed later on in this chapter in the context of the French criticism.

16. Although, as Partington remarks, the term phlogiston had been used before in the same sense (*252*, 86-87).

17. Unfortunately for Richter his dynamist view-point markedly hindered his making any impact on the advancing elemental chemistry. See Partington (*252*, 178).

18. For the sake of clarity here is a list of the most relevant scientific works referred to within the context of pneumatics, most of which Novalis made notes upon, and others which he had in all likelihood knowledge of; this is not a comprehensive list since there are many other scientific texts on the book lists in the Novalis critical edition, which could obviously also be of interest for his notions of pneumatics and chemistry in general (see *N*, 3, 754, 1002-1010, 1065-1066):

*Allgemeines Journal der Chemie*, ed. Alexander Nicolaus Scherer, Leipzig and Berlin, 1798-1803 (no. *5*).

*Neues Journal der Physik*, ed. Friedrich Albrecht Carl Gren, Leipzig, 1795- (no. *73*).

Berthollet, Claude Louis: 'Beobachtungen über die eudiometrischen Eigenschaften des Phosphors', in: *Allgemeines Journal der Chemie*, 1, 1798, 518-528 (no. *12*).

Delamétherie, J.C.: 'De la chemie', in:*Journal de Physique, de Chemie, d'Histoire naturelle et des arts, avec des planches en taille-douce*, ed. J.C. Delamétherie, Paris, 1798, 3, 85-134 (no. *22*).

Fourcroy, Antoine Francois de, and Louis Nicolas Vauquelin: 'Nachricht von Foucroys und Vauquelins Versuche mit dem Knallsalze', in: *Neues Journal der Physik*, 4, 1797, 238-241 (no. *30*).

--:'Prüfung der über das vorgebliche Leuchten des Phosphors im Stickstoffgas angestellten Untersuchungen; angestellt von den Bürgern Fourcroy und Vauquelin', in: *Allgemeines Journal der Chemie*, 1, 1798, 492-518 (no. *31*).

Göttling, Johann Friedrich August: *Beytrag zur Berichtigung der antiphlogistischen Chemie auf Versuche gegründet*, Jena, 1794 (no. *42*).

Gren, Friederich Albrecht Carl: 'Beschreibung eines sehr zuverlässigen und leicht anwendbaren Eudiometers vom Professor Gren', in: *Neues Journal der Physik*, 4, 1797, 363-369 (no. *47*).

Humboldt, Friedrich Alexander von: 'Abhandlung über die dreyfache Verbindung aus Phosphor, Stickstoff und Sauerstoff, oder über das Daseyn der Phosphures d'azote oxides', in: *Allgemeines Journal der Chemie*, 1, 1798, 573-589 (no. *55*).

Laplace, Pierre Simon de: *Darstellung des Weltsystems durch Peter Simon Laplace. Aus dem Französischen übersezt von Johann Karl Friedrich Hauff.* Theil I-II, Frankfurt a. M.: Varrentrapp und Wenner, 1797 (no. *68*).

Brugnatelli, L.G., Thomas Hoyle, Jean-Baptiste van Mons: 'Neue Beobachtungen über die Verpuffungen der salzsauren und salpetersauren Salze mit verschiedenen Körpern', in: *Allgemeines Journal der Chemie*, 1, 1798, 604-624 (no. *17*).

Prevost, Benedict: 'Fourcroy's Auszug aus einer Abhandlung des Bürgers Benedict Prevost in Genf, Mitgliedes d. Gesells. d. Wissens. u. Künste zu Montanbau, über die Ausflüsse riechender Körper; oder über die odoroscopischen Wirkungen warmer, kalter, riechender und geruchloser Substanzen', in: *Allgemeines Journal der Chemie*, 1, 1798, 143-166 (no. *84*).

Reboul, Heinrich: 'Beschreibung eines atmosphärischen Eudiometers von Herrn Heinrich Reboul', in: *Neues Journal der Physik*, 1, 1795, 374-379 (no. *89*).

Ritter, Johann Wilhelm: 'Madame Fulhame's Versuche über die Wiederherstellung der Metalle', in: *Allgemeines Journal der Chemie*, 1, 1798, 420-444 (no. *93*).

Rumford, Count Benjamin Thompson: 'Versuche und Beobachtungen über die Fortplanzung der Wärme in Flüssigkeiten', in: *Neues Journal der Physik*, 4, 1797, 418 f (no. *102*).

19. Compare, too, Ritter's remarks on hydrogen and light in the context of precursors of a notion of energy (see above, pp.258-260).

20. The works to which Ritter refers are: Torbern Olof Bergman, (no. *9*) *Opuscula physica et chemica*, 6 vols., Upsala, 1779-1790; (no. *11*) *Kleine physische und chymische Werke*, übersetzt von Heinrich Tabor, 6 vols., Frankfurt a.M., 1782-1790, 3, 519; and Lazzaro Spallanzani, in *Annales de Chemie*, 22, 248.

21. See Frances Yates on the Renaissance memory theatres of Giulo Camillo and Robert Fludd (*299*, 129-172, 320-341).

22. The letter is of 9. September 1798 (*N*, 4, 260-262).

23. The "Nervenaether" is a reference to Ritter's attempts to investigate nerve action in terms of affinity and electrochemistry. This is fully discussed in the next chapter.

24. Adler, when remarking on the genesis of Goethe's interests in affinity comments: "Soweit ich es überblicke, beginnen Goethes Anspielungen auf die chemische "Verwandtschaft" in seinen Notizen von 1793, dem Jahr, in dem er auch Bergmans Schema übernahm. Ihre Bedeutung ist vielleicht deswegen nicht erkannt worden, weil Goethe oft das Wort "Affinität" verwendet. Es gibt z.B. eine Aufzeichnung zur *Affinität des gefärbten Lichts zu den Phosphoren*. Ebenso gibt es Aufzeichnungen über die "Verwandtschaft" des Lichts" (*129*, 81; *40*, I, 3, 238).

25. There is also a summary of Brugnatelli's work on deflagration in Lorenz Crell's *Chemische Annalen*, 1, 1799, 259-271, 'Abgekürzte Mittheilung der neuen Beobachtungen des Herrn Brugnatelli über die Art durch Phosphor mit verschiedenen chemischen Körpern mit Knall begleitete Detonnationen zu bewirken' (*16; 19*). On the subject of detonation Novalis further may well have read the article in Gren's *Neues Journal der Physik*, 'Nachricht von Foucroys und Vauquelins Versuche mit dem Knallsalze' (*30*; *73*).

26. Novalis made notes for example on Laplace's comments on attraction in his work, *Darstellung des Weltsystems* (*68*), which the latter believed was a universal phenomenon, and, further, that it lay very much at the heart of chemical inquiry. Novalis noted down the following from Laplace: "Die Anziehungskraft verschwindet unter Körpern von unbeträchtlicher Größe. Sie scheint aber unter mannichfach veränderter Gestalt wieder bey ihren Elementen. Die Dichtigkeit der K[örper], ihre Krystallisation, die Brechung des Lichts, das Steigen und Fallen der Flüssigkeiten in den Haarröhren, und überhaupt alle chemischen Verbindungen sind Folgen der Anziehungskräfte. Aber

sind etwa diese Kräfte die in den Raeumen des Himmels beobachtete Gravitation selbst, auf der Erde durch die Gestalt der Integrirenden Theile modificirt?" (*N*, 3, 71; *68*, 2, 211). Novalis then remarks how decisively Laplace had refuted the idea of some that attraction was not universal: "Diese Le Sagesche und andrer Behauptung begleitet hier La Place mit sehr treffenden Bermerkungen, als unnütze und unbequeme Hypothese" (*N*, 3, 71). As the editor, Gerhard Schulz, points out, this refers to pages 211-214 of Laplace's work: "Um diese Hypothese anzunehmen müsste bey den Körpern viel mehr leeren, als erfüllten Raum voraussezen, so dass die Dichtigkeit ihrer Theilchen unvergleichbar grösser wäre, als die mittlere Dichtigkeit ihrer ganzen Massen. Ein sphärisches Element von 0,00001 Fuss Durchmesser müsste eine zum wenigsten zehntausend milliardenmal grössere Dichtigkeit haben, als die mittlere Dichtigkeit der Erde ist, um auf seiner Oberfläche eine der Schwere auf der Erde gleiche Attraction zu äussern ... Bey diesen Ungewissheiten ist das klügste, was man thun kann, sich an die Bestimmung der Geseze der Verwandtschaften durch zahlreiche Versuche zu halten ..." (*68*, 2, 211-214). For the importance of affinity for Laplace, see further Adler (*129*, 36).

27. Novalis most probably had read this work since, as mentioned, he had made notes on other articles in Scherer's first volume (for example (*55*), (*93*)). There is also a summary of Prevost's work in Gren's *Neues Journal der Physik*, 4, 1797, 242f., 'Auszug einer Abhandlung des Herrn Ben. Prevost in Genf, über die Ausflüsse riechender Körper, und über die Mittel, sie dem Gesicht bemerkbar zu machen' (*83*), and also in Crell's *Chemische Annalen*, 1800, 2, 232-254, 'Ueber die odoroskopischen Wirkungen warmer und kalter geruchloser Körper, und über die riechenden Substanzen' (*85*).

28. Bergen's work, which Fourcroy is citing, is *Nova acta physico-medica Academiae Naturae Curiosorum*, 1757, 1, 195 f.

29. Phosphorus, as well as playing a major role in Novalis's organic view of Nature, was also of strict pathological interest to him. In this role, it provided a further link between inorganic and organic organization. Novalis writes: "Phosphor soll eine sehr stimulirende Kraft besitzen. In Paris kurirt man Impotenzen und Erschöpfungen damit. Es wird Ph[osphor] in heißem Wasser geschüttelt - dann dieses Wasser in Kaltes gebracht - so schlägt sich ein feines Phosph[or]Mehl nieder - dies wird mit Ey vermischt - oder in Syrup gethan und so in sehr geringen Dosen gegeben" (*N*, 3, 199). Here, the medicinal powers of phosphorus establish a direct link between the combustible principle and the force of human generation: a dose of phosphorus (with a bit of honey) is actually said to cure impotence! The pathological theme also provides a direct link between Novalis's reading of Fourcroy and Vauquelin on the combustion of phosphorus and his own thought. Reading Fourcroy and Vauquelin, he notes: "Fourcroy schließt analogisch vom Phosphor auf ähnliche *Auflösungen* des Schwefels, der Kohle etc ... in den genannten Luftarten bey niedriger Temperatur" (*N*, 3, 188). Subsequently, in the *Das allgemeine Brouillon*, he remarks: "Im höchsten Grad auch *physiologisch*

*merckwürdig* scheint mir die Auflösung des Phosphors, des Schwefels *etc.* in Luftarten bey *niedriger Temperatur*" (*N*, 3, 472). For Novalis, Fourcroy's chemical observation becomes a matter of pathological interest.

30. The following alchemical texts are on Novalis's book list, and are all in the library at the Freiberger Bergakademie (given in the order they were written down in by Novalis):

Libavius, Andreas, *Alchymia*, Francofurti, 1597.

Meyer, Johann Friedrich, *Alchymistische Briefe*, Hannover, 1767.

Wedel, Georg Wolffgang, *Einleitung zur Alchemie*, Berlin, 1724 (No.*102*).

Becher, Johann Joachim, *Psychosophia oder Seelen-Weisheit*, Hamburg, 1725.

Rosenkreutz, Christian, *Chymische Hochzeit anno 1459*, Strassburg, 1616.

*Die edelgeborne Jungfrau Alchemia*. Nebst einem Zusatze von der Medicina universali, Tübingen 1730.

Geber, *Chimia sive traditio summae perfectionis et investigatio magisterri innumeris locis emendata*, a C.Hornio. Lugd. Bat., 1668.

*Quadratum alchymisticum, das ist: vier auserlesene rare Tractätgen vom Stein der Weisen*, Hamburg, 1705 (No.*80*).

I have dealt mainly with Wedel's work for the reason that it gives such a clear overview of alchemy. One should mention, however, that Geber goes into great detail on the possible properties of the "Stein der Weisen" and also on alchemical practice, and that this would have enriched the views that Novalis would have gained through a reading of Wedel. For a summary of Geber's outlook, see Holmyard (*201*, 134-141). Becher and Rosencreutz would also have been important to Novalis for alchemical issues, and Rosencreutz's notion of the chemical marriage and the particular literary form of his work are most probably important sources, perhaps even models, for Novalis's own idea of a "natural philosophical" literary form, as is obviously found in *Heinrich von Ofterdingen.* This, however, is an issue that lies beyond the present inquiry.

31. See the remarks of Crosland and Adler in footnote 9 of chapter one and see also footnote 13 of this chapter.

## Chapter Four

1. See in particular Berg and Richter, (*142*, 34-35). They point to two laws arising from Ritter's work, "der Rittersche Öffnungstetanus" and "der Pflügerische Zuckungsgesetz". Berg and Richter treat a whole series of experiments from Ritter's 1798 *Beweis* in terms of their value for modern

science, but, understandably, given this stance, do not tackle the key experiments (*figures 67-71*) discussed in this present work.

2. See, for example, Berg and Richter, (*142*, 34).

3. As mentioned (above, p.292), Berg and Richter refer to Ritter's work as "bioelectrochemistry".

4. The lectures are printed in *6*, 10 (1802), 389-420 and 421-449.

5. Ritter remarked "Unverzeilich bleibt es mir immer dieser Entdeckung so in der Nähe gewesen zu seyn, ohne je von dem, was ich täglich in Händen hatte, Anwendung zu machen" (*95*; *98*, 1, 281)).

6. See (*6*), vol.4 (1800), 2, footnote.

7. Although, as already discussed, Volta did not entirely overlook organic electricity, he was none the less essentially interested in physical electricity per se and not electricity within organisms. I wish to stress this point to make the aim and purpose of Ritter's *Beweis* clear. Ritter clearly had to argue against Volta's stance, and account for an "organic" notion of galvanism, but this does not mean that Ritter neglected the "inorganic" aspects of galvanic theory.

8. Gower sees in Ritter's use of the notion "Grundkräfte" an "adaption of Schellingean metaphysical ideas" (*180*, 338). He compares Ritter's explanation of galvanic phenomena in terms of dynamic forces and individuals as a "tripartite scheme, reminiscent of Kant's and Schelling's architectonic methods ..." (*119*, 331). Gower, however, although contributing to an understanding of Ritter's natural philosophical notions in terms of German dynamism, makes little mention of physiology. But he does, importantly, see "the most interesting feature of his work" in "Ritter's attempt to deploy a presuppositional framework ..." (*180*, 338-339). This present work aims to delineate such presuppositions, and, in particular, to illustrate them in the light of early Romantic notions of practical knowledge. Thus, it is argued that Ritter's contribution to science lies as much in his methodology as in his actual findings.

9. C.F.Kielmeyer (1765-1844) explains thus: "Reproductionskraft, oder die Fähigkeit der Organisationen, sich selbst ähnliche Wesen Theilweise oder im Ganzen nach- und anzubilden ..." (*63*, 251). "Propagation" may not specifically refer to reproduction - it could also refer to "transmission". Be that as it may, whether as a force of reproduction or of "transmission", it would apply to activity in organisms alone, and not to a force in the inorganic realm. For a force perhaps analogous to the one of "transmission" see Kielmeyer's "Propulsionskraft". Kielmeyer's five forces in organisms are: "1. Sensibilität oder die Fähigkeit mit Eindrüken, die auf die Nerven oder sonst gemacht werden, gleichzeitig Vorstellungen zu erhalten, 2. Irritibilität oder die Fähigkeit mancher Organe, vorzüglich der Muskeln, auf Reize sich zusammenzuziehen, und Bewegungen hervorzubringen, 3. Reproductionskraft, oder die Fähigkeit der Organisationen, sich selbst ähnliche Wesen Theilweise oder im Ganzen nach- und anzubilden, 4. Sekretionskraft oder die Fähigkeit aus der Saftmasse dieser selbst unähnliche Materien von bestimmter Beschaffenheit wiederholt an bestimmten Orten abzusondern, 5. Propulsionskraft, oder die Fähigkeit, die

Flüssigkeiten in den vesten Theilen in bestimmter Ordnung zu bewegen und zu vertheilen" (*63*, 251).

10. Novalis even had notions of a theory of the "constitution", as Neubauer has pointed out (*337*, 72-73):

"1. Constitution mit mangelnder Reitzbarkeit. (indirect asth[enisch])

2. C[onstitution mit überflüssiger Reitzbarkeit. (direct asth[enisch])

a. C[onstitution] mit überflüssiger Incitation (direct sthenisch)

b. C[onstitution] mit mangelnder Incitation (indirect sthenisch). ..." (*N*, 2, 573). Even in this form Novalis's notion of the constitution here reveals that he saw many factors at work, and that, in a fashion typical to him, he was broadening the parameters of theory. Neubauer directs us to the fact that Novalis's new category in his theory of "constitutions" was a form of "Sthenie". This is of interest to Novalis's view on the "sthenic", and its counterparts, oxidation and concrete thought: the above remark would seem to be another instance of this concern of his. In a further comment, for instance, Novalis speculates that oxidation is the path to the Golden Age: "Luftvernichtung ist Herstellung des Reichs Gottes" (*N*, 3, 659).

11. For an interesting English distinction of this awareness of the reductive nature of Brunonian principles, see Lawrence (*233*, 11-12), who describes how Thomas Morrison, a supporter of John Hunter, attacked Brown for his reduction of life to a principle. Some Brunonians did indeed look at patients closely, in another sense of the "Individuum", as an individual case. Joseph Frank (1771-1842), for example, instead of looking at a patient in terms of symptoms or previous diseases, made a thorough history of the patient, taking account of psychological factors, life-style and environment (*264*, 54-57). Franz Anton Mai went further and claimed that case histories were not reliable since the patient's information was by no means always complete: it was no use just coming to some diagnosis over the patient's symptoms and then applying Brunonian theory. The patient had to be closely monitored and in critical stages of an illness visited and reassessed every three hours (*264*, 60).

12. Schelling's stance to galvanism in 1798 can explain a remark of Novalis's on Schelling that critics have failed to come to terms with: "Schelling geht nur von dem Irritabilitätsphaenomèn der Welt aus - er legt den Muskel zum Grunde - Wo bleibt der Nerv - die Adern - das Blut - und die Haut - der Zellstoff. Warum geht er, der Chymiker, nicht vom Process aus - von dem Phaenomèn der Berührung - der Kette" (*N*, 3, 470). Neubauer finds this remark confused and confusing (*337*, 159), and Burwick (*306*, 132-133), although taking Ritter into account, oversimplifies Schelling's view of Nature, since Schelling did not, as Burwick maintains, completely reduce Nature to spasms or polarities but, was, in his *Von der Weltseele* of 1798, defending the "dignity" of a purposive notion of phenomena against mechanist theories. The proper context of this remark of Novalis's is this: although Schelling sides with Ritter in 1799, he had not in 1798 properly come to terms with

the issues of galvanism in Ritter's work. In 1798 Schelling defends Humboldt's view of galvanism as a purposive force in the organic against Volta's notion of contact electricity. In doing so Schelling takes the view that the final cause of galvanism must lie within the irritable organs: "Daß der letzte Grund der galvanischen Erscheinungen in den irritabeln Organen selbst liege, scheint jetzt durch die Humboldtschen Versuche entschieden, und so wäre Galvanis große Entdeckung wieder in die Dignität eingesetzt, die ihr Voltas Scharffsinn zu rauben drohte" (*107*, 555). However, Schelling realized that Humboldt's experiments, although they had reinforced the "dignity" of Galvani's theory and revealed the inadequacy of Volta's mechanist interpretation, do in themselves only put forward a hypothetical solution to galvanic action: "Humboldts eigne Theorie beruht auf einer bloßen Möglichkeit und erklärt einige Phänomene in der That gar nicht" (*107*, 557). Schelling, unlike Humboldt, but like Ritter and Novalis, views galvanism as a universal force, yet, in contrast to Ritter and Novalis, cannot make any concrete link between the inorganic and the organic: "Dieser Satz: daß heterogene Metalle entgegengesetzte Beschaffenheiten in N. und M. (nerve and muscle) - (einen Dualismus der Principien) - erwecken, oder wieder trennen, was im Leben continuirlich getrennt wird ..., muß als Princip aller weiteren Untersuchung zu Grunde gelegt werden" (*107*, 558). Schelling makes the fundamental leap to link the galvanic action in the inorganic, in the metals, with galvanic action in the organic realm, but was not yet aware of or able to view the organic in terms of inorganic action, for Schelling does not see the notion of the chemical "Process" or the physical notion of the closed circuit ("Kette"). Furthermore, although Schelling indeed points to the importance of the nerve to galvanic action in the sensibility of the nerve, he seemingly argues for Humboldt's notion of galvanic action in open circuits. He thereby again was not yet aware of the fundamental physical law of galvanic action which necessarily takes place in closed circuits, and misses Ritter's idea of a whole "closed" process: "... daß, sage ich, in allen diesen Fällen Zuckungen entstehen können, weil diese leiseste Veränderung des Nerven den Dualismus der Principien in N. und M. und dadurch den Proceß wieder anfachen kann, der sogar oft freiwillig geschieht, wenn das sich selbst überlassene Organ ohne äußeren Stimulus, von selbst gleichsam sich entladend, in Zuckungen geräth" (*107*, 558). In the light of Ritter's constant galvanic action, Schelling's method of viewing galvanism in the organic in terms of the polarities of irritability and sensibility alone is an inadequate explanation, and Schelling's above interpretation of the nerve highlights how important Ritter's own understanding of nerve action was. Novalis reiterates both Ritter's universal and inorganic view of the nerve in the following remark: "Die Nerven sind Gefäße und bestehn eigentlich ganz aus Muskularsubstanz - mithin muß der eigentliche Character des Nerv[s], der Grund der Sensib[ilitaet] in dem Marke, in der Gehirnsubstanz stecken. Das Mark ist ein Übergang der Flüssigen und festen Theile - Es ist ein organisirter Brey" (*N*, 3, 659). Nerve action should, on his view, be understood in terms of chemistry in its widest sense, as organized matter. The nerve for Novalis, as a product of the muscle and marrow, could symbolize generative action in both the organic and inorganic realm.

13. The chart of Brown's is given in of Neubauer's work (*337*, 173). The chart is taken from P. Diepgen, *Geschichte der Medizin*, 2 vols., Berlin, 1949-1955, 2, pt.i.

14. In another remark Novalis again links up the notion of the generative "Individuum" to the force of "Sympathie": "Die Individualitaet in der Natur ist ganz unendlich. Wie sehr belebt diese Ansicht unsre Hoffnungen von der Personalitaet des Universums. Bemerkungen über das, was die Alten Sympathie nannten?" (*N*, 3, 665).

15. On this grand scale "die innre chiffrirende Kraft" is bound up with Novalis's notion of "Naturgedächtniß" (*N*, 3, 419). Novalis's notion of the process of evolution can, perhaps, be interpreted in his terms of experiential knowledge, as "experimental". The generative force in the activities and processes of phenomena can be seen as a teleological "generative induction" of evolution: in their activities bodies pass on their "personality" to other bodies, and, at the same time, form new "individuals". Evolution is rooted in what Nature already knows, i.e. her experiential "know-how", ("Das Gedächtniß ist der Individualsinn - das Element der Individuation" (*N*, 3, 434)). By bringing the notions of memory and experiential knowledge to bear on teleology, Novalis adds some novel aspects to the Neoplatonic notion of the Chain of Being. Bearing the notions of memory, experiential knowledge and representation in mind, Novalis's idea of the Chain of Being can be interpreted not only as a proposal of the Neoplatonic idea of continuity of form, but also, at the level of representation, it interprets the notion of purposiveness in the Chain of Being in a highly concrete way, as the physical continuity of "knowledge" in natural phenomena. Novalis's following remark can perhaps be interpreted itself in terms of the "Representationen" of phenomena:

Mehrere Stoffe zusammen bilden organische Stoffe -
Mehrere Kräfte zusammengenommen lebendige Kräfte -
Mehrere Contractionen - Empfindungen - Mehrere Sensationen Gedanken - Mehrere Gedanken Ideen - etc.

Mehrere Menschen - Genien.
Mehrere Thiere - Menschen.
Mehrere Pflanzen, Thiere.
Mehrere Stoffe - Pflanzen.
Mehrere Elemente Stoffe. (*N*, 3, 611).

Ritter's notion of circuits within circuits, within the whole circuit of Nature, fits closely into the idea of the Chain of Being and Novalis's scheme of things, for the idea of organizations within organizations allows for development and transitions in the Chain of Being through galvanic "representation".

16. In the following remark Novalis speculates, in a vitalist manner, that galvanism itself might be the soul of nature ("innres Licht"): "Sollte der Galv[anism] etwas anders seyn, als innres Licht. Spur der Empfindung im anorgischen Reiche" (*N*, 3, 604). The notion of matter theory here also recalls Plotinos's "inner light" (see chapter two, section 1.7).

17. Mähl and Kapitza both give an analysis of Novalis's triadic vision of the world. For the relation of this notion to Novalis's reception of Hemsterhuis, see Mähl (*331*, 278-281). In relation to Fichte, see Mähl (*331*, 282-286). Kapitza's comments are of particular interest in this context since he puts forward a "physical" version of Novalis's triadic historicism: "Im anfänglichen Chaos sind "Mischung und Bewegung" (Stoff und Kraft) noch eins" (*N*, 3, 246). In einer zweiten Phase - die Novalis als den gegenwärtigen Zustand annimmt - trennen sich beide und werden durch die Chemie als die Wissenschaft von den "Stoffmischungen" und die Mechanik als die "Bewegungsveränderingskunst" (*N*, 3, 247) jeweils für sich dargestellt. In einer dritten Phase aber sollen beide wieder vereinigt sein, und zwar "simultan", "geparrt durch gegenseitige Zueignung", harmonisch zusammenwirken: "Kraft und Stoff in Harmonie" (*N*, 3, 247). Eine auf diese Weise entstehende "verbundete Chemie und Mechanik" (N, 3, 246) hat eine direkte Beziehung zur "Verwandlung des Chaos in harmonischen Himmel und Erde" (*N*, 3, 246)" (*322*, 18).

18. As mentioned, Humboldt's similarity with Goethe, Novalis and Ritter here lies more, I would argue, emphatically in his geological or biogeological work. Ritter refers to the fallacy of theoretical and formal impossibilities such as one meets in Volta's and Humboldt's "separate" notion of Nature in general in the following way: "Wie aber durch bloße Addition von Nichts und Nichts, Etwas, wie 0 + 0 = 1 werden könne, das ist schlechthin unbegreiflich und darum unmöglich. - Wie das nun aber mit dem Werden eines Etwas aus Nichts, eben so möchte es auch mit dem Uebergang eines Etwas zurück in Nichts, oder wie, wenn n eine endliche Zahl bedeutet, 1/n = 0 (die Ziffer) werden könne, der Fall seyn" (*R*, 145). Humboldt and Volta both argue for "absolute" factors of galvanism which are relative, and it is the separateness (from concrete reality) of their factors which makes them relative since they are not constant phenomena, not permanent concrete references, but in reality, in Ritter's view, relative, changing concrete references. It is the "constant galvanic force" which is the ultimate "concrete" phenomena.

19. See *N*, 3, 544 for the dating of this remark.

## Conclusion

1. Naturally, the terminology of a thinker such as Frank is more precise in elucidating the type of language this present work points to.

# Appendix A

*Novalis's major references to "experiment".*

*Experimentalmethode* der reinen Vernunft (*N*, 2, 386)

*Werner. Experimentiren.* (*N*, 2, 669)

Philosophische Instruction für den Experimentator.
Sollte die *Flamme*, der Funken, etc. in ein *neues Reich* gehören, das von Pflanzen, Thier, und Menschenreich verschieden wäre. Lebendige Processe.
4 Arten von Flammen - 1. diejenige, deren Excremente - die anorgischen Naturen sind. 2. deren Excremente - Pflanzen - 3. deren Excremente - Thiere. 4. deren Excremente - Menschen sind. Je höher die Flamme - Je *künstlicher* - desto complicirter gebildeter das Excrement.
Alles Fressen ist ein Assimilationsprocess - Verbindungs - Generationsprocess (*N*, 3, 84-85).

Das universalste Naturfaktum muß eine unendliche Reihe variirender Erscheinungen - *einzelner wircklicher Phaenomene - Experimente* - unter sich haben.
Ansicht eines Experiments in einer *steigenden* Reihe von Gesichtspuncten.
*Übersetzung in die Instrumentalsprache* (*N*, 3, 91).

Die Plastisirungsmethode ist die ächte Experimentalmethode (*N*, 3, 123).

Zum Experimentiren gehört *Naturgenie*, d.ist, wunderartige Fähigkeit den Sinn der Natur zu treffen - und in ihrem Geiste zu handeln. Der ächte Beobachter ist *Künstler* - er *ahndet* das *Bedeutende* und weiß aus dem seltsamen, vorüberstreichenden Gemisch von Erscheinungen die Wichtigen herauszufühlen (*N*, 3, 179).

Wie wenig Menschen haben *Genie* zum Experimentiren. Der ächte Experimentator muß ein *dunkles Gefühl der Natur* in sich haben, das ihn, je vollkomner seine Anlagen sind, um so sicherer auf seinem Gange leitet und mit desto größerer *Genauigkeit* das versteckte entscheidende Phaenomèn finden und bestimmen läßt. Die Natur *inspirirt* gleichsam den ächten Liebhaber und offenbart sich um so vollkommner durch ihn - je harmonischer seine *Constitution* mit ihr ist. Der ächte Naturliebhaber zeichnet sich eben durch seine Fertigkeit die Experimente zu vervielfältigen, zu vereinfachen, zu combiniren, und zu Analysiren, zu romantisiren und popularisiren, durch seinen Erfindungsgeist neuer Experimente - durch seine Naturgeschmackvolle oder Natursinnreiche Auswahl und Anordnung derselben, durch Schärfe und Deutlichkeit der Beobachtung, und artistische, sowohl zusammengefaßte, als ausführliche Beschreibung, oder Darstellung der Beobachtung aus. Also - Auch Experimentator ist nur das Genie (*N*, 3, 256).

Wenn der Satz, oder die Verhältnisse - der Gegenst[and] oder der Begriff - richtig gewählt sind - wircklich Eins sind - so muß auch die Demonstration und Auflösung - das Experiment und die Erklärung - *durchaus* übereinkommen.
Wie das Experiment die bloße Erweiterung - Zertheilung - *Vermannichfaltigung* - *Verstärckung* des Gegenstandes ist, so ist die Erklärung dasselbe vom Satze - Hier gilt also der Satz:
Was vom *niedern Grade* gilt, muß auch vom *höhern Grade* gelten. Was im niedern Grade *durchaus eins* ist, muß auch im *höhern Grade* durchaus *Eins seyn* (*N*, 3, 353).

EXPERIMENTALLEHRE. Berichtigung v[on] Werners Classificat[ions] System - Seine Schrift. Unaufhörliche Kritik der Beobachtung - Vergleichung der Beobachtungen (Vervielfältigung der Versuche)

Der Beobachtungsproceß ist ein zugl[eich] subj[ectiver] und object[iver] Process - ideales und reales Experiment zugleich. Satz und Produkt müssen - zugl[eich] fertig werden, wenn er recht vollk[ommen] ist ... (*N*, 3, 357).

Experimentalphysik des Geistes (*N*, 3, 387).

Alles kann zum Experiment - alles zum *Organ* werden. Ächte Erfahrung entsteht aus ächten Experimenten. (*Versuche* sind Experimente.) Fichte lehrt das Geheimniß des Experimentirens - er lehrt Thatsachen und Thathandlungen, oder wirckliche Sachen und Handl[ungen] - in Experimente und Begriffe verwandlen. Sachen in entgegenges[etzte] Handl[ungen], in Begriffe - Handl[ungen] in entg[egengesetzte] Sachen - auch in Begriffe. Diese Begriffe hängen zusammen - die Handl[ungen] und Sachen hängen zusammen - und alle 4 hängen gleichzeitig zusammen (*N*, 3, 391).

Sollte es sich bestätigen, daß der Satz des Widerspruchs der Grundsatz des Denkvermögens, der *Oberste* der *Logik*, sey, so wäre dies nur eine Indication , daß wir mit der Logik *allein* nicht viel ausrichten könnten, daß das Denkverm[ögen] *allein* keinen (großen) Nutzen gewähre - sondern, daß wir noch ein andres Vermögen und seine Theorie aufsuchen müßten, die als dem Denkvermögen und d[er] Logik entgegengesezt und *allein* eben so nutzlos, als diese, in Verbindung mit diesen gesezt werden müßten, um daraus ein zusammengeseztes Vermögen - und zusammengesezte, sich gegenseitig complettirende Theorieen und Handl[ungen] und Resultate zu erlangen und so fort.
*Am Ende* scheint alles Nachdenken auf ächtes Experimentiren zu führen - und die sog[enannte] Vernunftlehre - die Nothwendigkeit, Methode, etc. des Experimentirens und *Lebens*, als eines beständigen Experimentirens zu enthalten und beweisen.
*Die vollendete Speculation führt zur Natur zurück.*
Das ganze Geheimniß des Philosophirens liegt in der generalisirten Baconischen Sentenz - Philos[ophia] *abducit* et *reducit* - die Abduktion ist der Reduktion wegen. Die Natur ist aber weit mehr, wenn sie durch das Phil[osophische] Organ gegangen ist (*N*, 3, 402-403).

Man geht mit den Erfahrungen und Experimenten noch viel zu sorglos um - Man versteht sie nicht zu benutzen - Man betrachtet zu wenig die Erfahrungen - als Data zur Auflösung und mannichfaltigen Combinationen zum Calcül - Man überlegt die Erfahrungen, in Beziehung auf Schlüsse, nicht sorgfältig genug - Man nimmt nicht jede Erfahrung, als Function und Glied einer Reihe an - man ordnet - vergleicht - und simplificirt die Erfahrungen nicht genug - man prüft einen Gegenstand nicht mit allen *Reagentien* - man vergleicht ihn nicht fleißig - und mannichfach genug (*N*, 3, 427).

*Vervielfältigung* - *Wiederholung* - *Zertheilung* - (Addition - Multiplication - Exponenziation etc.) von Experimenten. Zusammensetzung von *Experimenten*.
(Experimentencalcul.)
*Experimentiren* ist gewissermaaßen nichts, als *calculiren*.
(Aller Calcül ist Analytisch - *inventorisch*)
Muster des Experimentirens.(Phosphor - Kampfer) (*N*, 3, 435).

Werner hat die *Theorie* eines *speciellen* Beobachtungsprocesses geliefert - Auf diesem Grunde kann man weiter bauen -
*Allg[emeine]* Theorie des Beobachtens und Experimentirens - und Einzelne, specielle Processe, als Beyspiele.
*Practische* Theorie d[es] B[eobachtens] und Exp[erimentirens] (*N*, 3, 437).

Geschichte der Versuche Versuche zu stande zu bringen. Die Idee eines Versuchs zu realisiren - gutgeordnete Beschreibungsreihe der Experimentalversuche sind wohl ebenfalls Synonymen d[er] phil[osophischen] Geschichte (*N*, 3, 439).

Diogenes Gehn- war *Experimentalphil[osophie]* - ächtsynth[etische] Phil[osophie] (*N*, 3, 439).

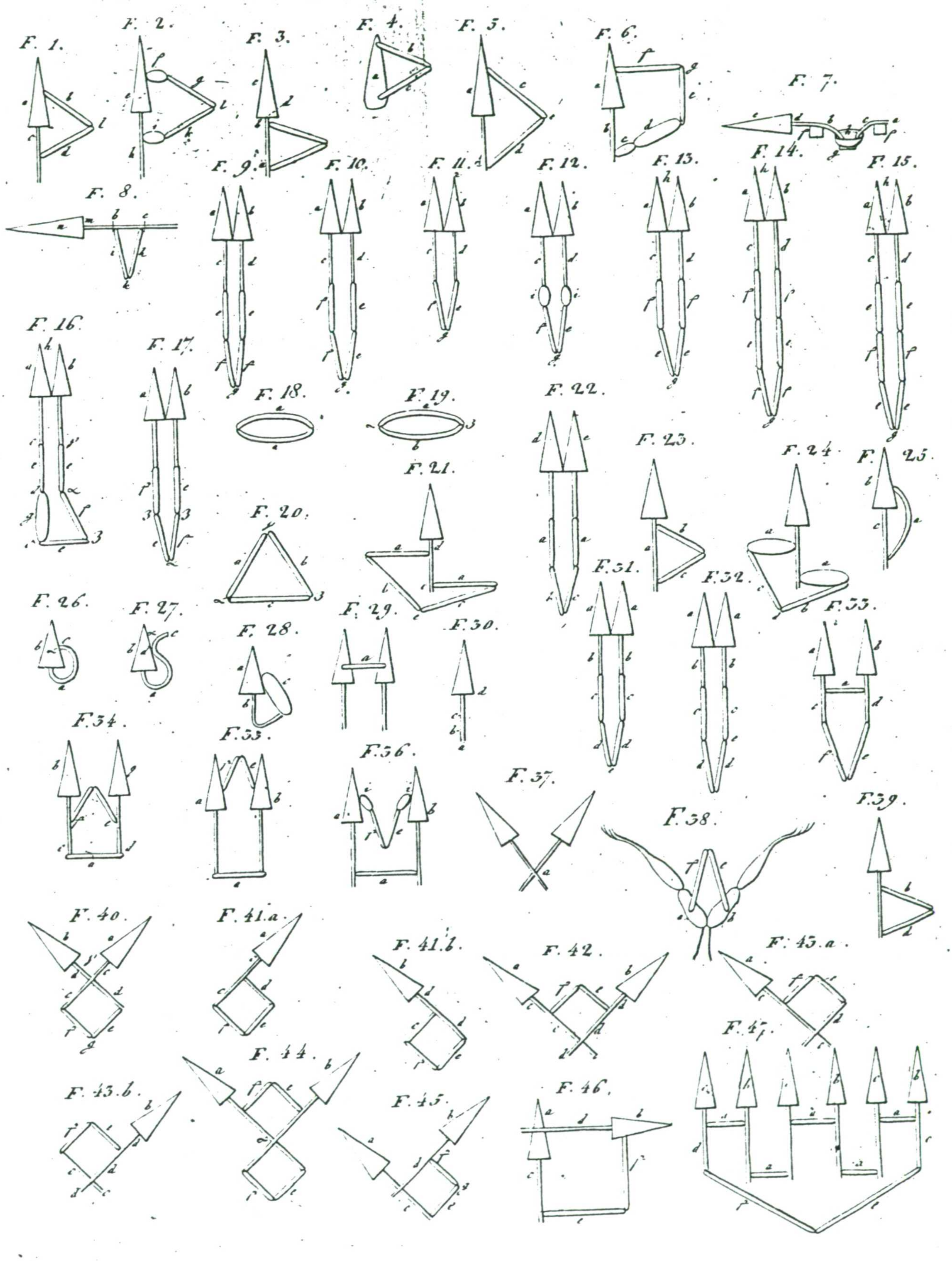
Plotin war schon in Betreff der meisten Resultate - kritischer Idealist und Realist./Fichtes und Kants Methode ist noch nicht vollst[ändig] und genau genug dargestellt. Beyde wissen noch nicht mit Leichtigkeit und Mannichfaltigkeit zu experimentiren - überhaupt nicht *poëtisch* - Alles ist so steif, so ängstlich noch. Die freye *Generationsmethode* d[er] Wahrheit kann noch sehr erweitert und simplificirt - überhaupt verbessert werden. Da ist nun diese ächte Experimentirkunst - Die *Wissenschaft* des *thätigen Empirismus* (*N*, 3, 445).

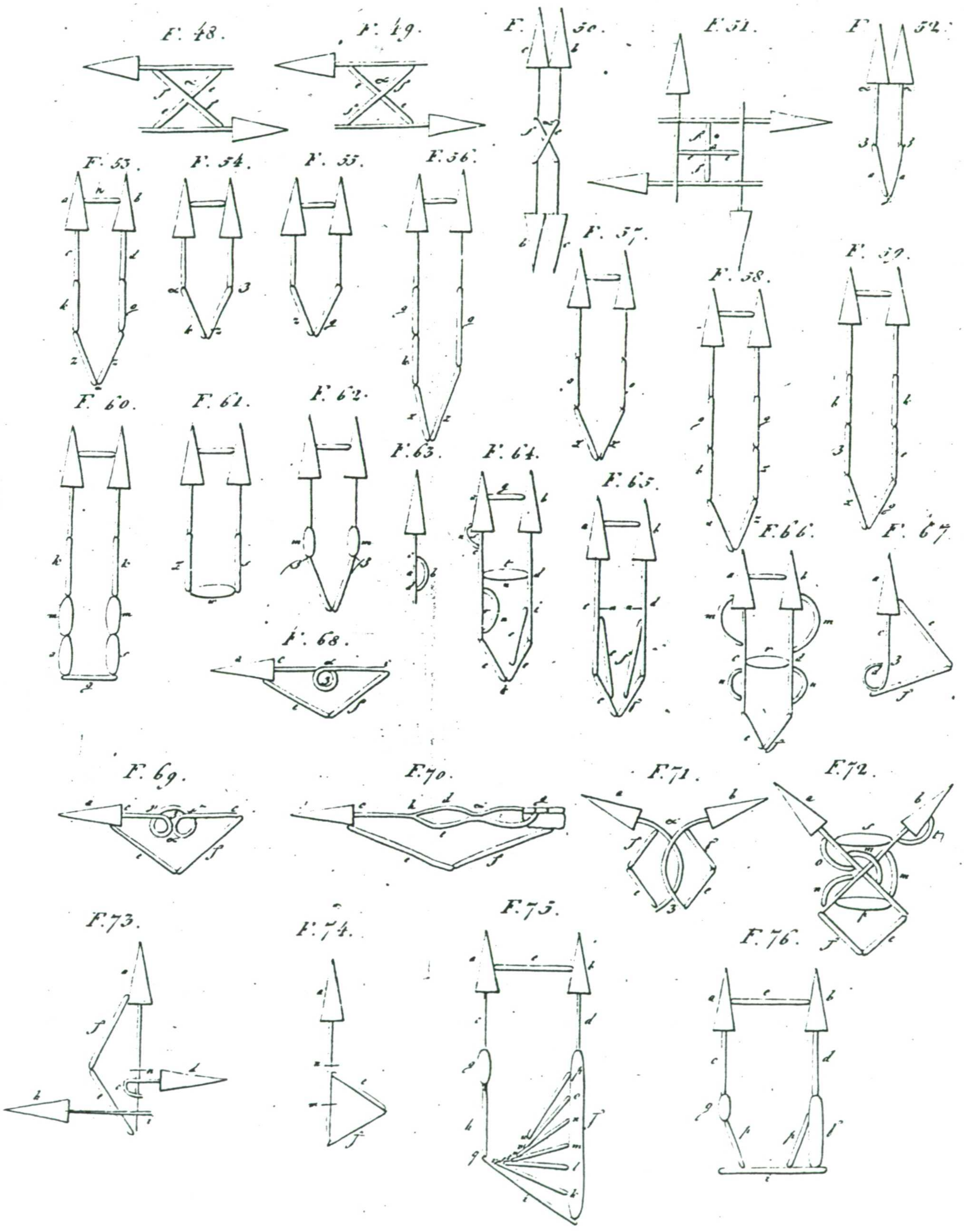
Ein Phaenomèn muß nothwendig zu andern Phaenomènen führen, wie Ein Experiment zu mehreren Experimenten. Die Natur ist ein *Ganzes* - worinn jeder Theil an sich nie ganz verstanden werden kann. Der ächte Naturforscher geht von irgend einem Puncte aus und verfolgt seinen Weg Schritt vor Schritt in die Unermeßlicheit hinein mit sorgfältiger Verknüpfung und Aneinanderreihung der einzelnen Thatsachen.
So z.B. Verfolgung des Verbrennungsprocesses (*N*, 3, 603).

Ritter sucht durchaus die eigentliche Weltseele der Natur auf. Er will die sichtbaren und ponderablen Lettern lesen lernen, und das *Setzen* der höhern geistigen Kräfte erklären. Alle äußre Processe sollen als Symbole und lezte Wirkungen innerer Processe begreiflich werden. Die Unvollständigkeit jener soll das Organ für diese und die Nothwendigkeit einer Annahme des Personellen, als lezten Motivs, Resultat jedes Experiments werden (*N*, 3, 655).

# Appendix B

Ritter's galvanic diagrams (*Beweis*, 1798)




F. 48.
F. 49.
F. 50.
F. 51.
F. 52.
F. 53.
F. 54.
F. 55.
F. 56.
F. 57.
F. 58.
F. 59.
F. 60.
F. 61.
F. 62.
F. 63.
F. 64.
F. 65.
F. 66.
F. 67.
F. 68.
F. 69.
F. 70.
F. 71.
F. 72.
F. 73.
F. 74.
F. 75.
F. 76.

# Bibliography

## *I. Works by Novalis*

1. *Schriften. Die Werke Friedrich von Hardenbergs*, eds. Paul Kluckhohn and Richard Samuel. Zweite, nach den Handschriften ergänzte, erweiterte und verbesserte Auflage in vier Bänden und einem Begleitband, 5 vols., Stuttgart; Berlin; Köln; Mainz: Kohlhammer, 1960-1988.

Vol.1. *Das dichterische Werk*, eds. Paul Kluckhohn and Richard Samuel together with Heinz Ritter and Gerhard Schulz, 1960; 3rd enlarged and revised edition, 1977.

Vol.2. *Das philosophische Werk I*, eds. Richard Samuel, Hans-Joachim Mähl, and Gerhard Schulz, 1965; 3rd edition, 1981.

Vol.3. *Das philosophische Werk II*, eds. Richard Samuel, Hans-Joachim Mähl, and Gerhard Schulz, 1968; 3rd edition 1983.

Vol.4. *Tagebücher, Briefwechsel, Zeitgenössische Zeugnisse*, eds. Richard Samuel, Hans-Joachim Mähl, and Gerhard Schulz, 1975.

Vol. 5. *Materialien und Register*, eds. Hans-Joachim Mähl and Richard Samuel; index by Hermann Knebel, 1988.

2. *Werke, Tagebücher und Briefe Friederich von Hardenbergs*, eds. Hans-Joachim Mähl and Richard Samuel, Munich and Vienna, 1978-1987.

Vol.1. *Das dichterische Werk, Tagebücher und Briefe*, ed. Richard Samuel, Munich and Vienna, 1978.

Vol.2. *Das philosophisch-theoretische Werk*, ed. Hans-Joachim Mähl, Munich and Vienna, 1978.

Vol.3. *Kommentar*, Hans Jürgen Balmes, Munich and Vienna, 1987.

3. *Novalis Werke*, ed. Gerhard Schulz, 2nd edition, Munich, 1981.

## *II. Eighteenth century and earlier sources*

4. Agrippa von Nettesheim, Heinrich Cornelius: *De occulta philosophia Sive de magia libri tres*, Cologne, 1533.

5. *Allgemeines Journal der Chemie*, ed. Alexander Nicolaus Scherer, Leipzig and Berlin, 1798-1803.

6. *Annalen der Physik*, ed. Wilhelm Ludwig Gilbert, Halle, 1799-.

7. Bacon, Francis: *Novum Organum*, 2 parts, London, 1620, in: *The new organon and related writings*, ed. F.H. Anderson, trans. Ellis, Spedding and Heath, New York, 1960.

8. Becher, Johann Joachim: *Physicae subterraneae*, Frankfurt, 1669.

9. Bergman, Torbern Olof: *Opuscula physica et chemica*, 6 vols., Uppsala, 1779-1790.

10. -: *De attractionibus electivis*, in: *Opuscula physica et chemica*, 1779-1790, (no. 9), vol.3 (1783), pp. 291-470.

11. -: *Kleine physische und chymische Werke*, trans. Heinrich Tabor, 6 vols., Frankfurt a. M., 1782-1790. Translation of no. 9.

12. Berthollet, Claude Louis: 'Beobachtungen über die eudiometrischen Eigenschaften des Phosphors', in: *Allgemeines Journal der Chemie*, (no. 5), 1 (1798), 518-528.

13. Blumenbach, Johann Friedrich: 'Ueber den Bildungstrieb und das Zeugungsgeschäfte', in: *Göttingischen Magazin der Wissenschaften und Literatur*, 1 (1780), 247-266.

14. Boyle, Robert: *New Experiments, and Observations, made upon the Icy Noctiluca*, London, 1681-2.

15. Brown, John: *The works of Dr.John Brown with a Biography by W.C.Brown*, 2 vols., London, 1804.

16. Brugnatelli, L.G.: 'Abgekürzte Mittheilung der neuen Beobachtungen des Herrn Brugnatelli über die Art, durch Phosphor mit verschiednen chemischen Körpern mit Knall begleitete Detonnationen zu bewirken', in: *Chemische Annalen für die Freunde der Naturlehre*, (no. 19), 1799, 1, 259-271.

17. Brugnatelli, L.G., Thomas Hoyle, Jean-Baptiste van Mons: 'Neue Beobachtungen über die Verpuffungen der salzsauren und salpetersauren Salze mit verschiedenen Körpern', in: *Allgemeines Journal der Chemie*, (no.5), 1 (1798), 604-624.

18. Cavendish, Henry: 'Experiments on Air', in: *Philosophical Transactions* 74, 1 (1784), 119-153.

19. *Chemische Annalen für die Freunde der Naturlehre, Arzneygelahrtheit, Haushaltungskunst, und Manufakture*, ed. Lorenz von Crell, Helmstädt, 1799 and 1800.

20. Condorcet, Marie Jean Antoine de: *Entwurf eines historischen Gemähldes der Fortschritte des menschlichen Geistes. Nachlaß von Condorcet, in's Teutsche übersezt durch D. Ernst Ludwig Posselt*, Tübingen, 1796.

21. Cuvier, Georges and Alexandre Brongniart: 'Essai sur la géographie minéralogique des environs de Paris', in: *Mémoires de l'Institut imperial de France*, an 1810 (1811), 1-278.

22. Delamétherie, J.C.: 'De la chemie', in: *Journal de Physique*, (no.61), 1798, Heft 1, 85-134.

23. Diogenes Laertius: *Leben und Meinungen berühmter Philosophen*, trans. Otto Apelt, 2 vols., Hamburg, 1967.

24. -: *Vitae philosophorum*, ed. H.S.Long, 2 vols., Oxford, 1964 (Oxford Classical Texts).

25. Eschenmayer, Carl August: *Säze aus der Natur-Metaphysik auf chemische und medicinische Gegenstände angewandt*, Tübingen, 1797.

26. Fabbroni, Giovanni Valentino Mattia: 'Sur l'action chimique des differens metaux', in: *Journal de Physique*, (no.61), 49 (1799), 348-357.

27. Farey, John: *General view of the agriculture and minerals of Derbyshire, with observations on the means of their improvement*, London, 1811.

28. Fichte, Johann Gottlieb: *Gesamtausgabe der Bayerischen Akademie der Wissenschaften*, ed. Reinhard Lauth and Hans Gliwitzky, part one, 7 vols., part two, 8 vols., part three, 5 vols., part four, 2 vols., Stuttgart-Bad Cannstatt, 1964-1985.

29. Fischer. E.G.: 'Berthollets neue Theorie der Verwandtschaft', in: *Allgemeines Journal der Chemie*, (no.5), 7 (1801), 503-525.

30. Fourcroy, Antoine Francois de, and Louis Nicolas Vauquelin: 'Nachricht von Foucroys und Vauquelins Versuche mit dem Knallsalze', in: *Neues Journal der Physik*, (no.73), 4 (1797), 238-241.

31. -: 'Prüfung der über das vorgebliche Leuchten des Phosphors im Stickstoffgas angestellten Untersuch ungen; angestellt von den Bürgern Fourcroy und Vauquelin', in: *Allgemeines Journal der Chemie*, (no.5), 1 (1798), 492-518.

32. Fuchs, Johann Nepomuk: *Über die Theorien der Erde*, Munich, 1844.

33. Fulhame, Mrs Elizabeth: 'An Essai on Combustion, etc., ou Essai sur Combustion, avec des vues sur un nouvel art de teinture et de peinture, dans lequel on prouve que les hypothèses phlogistiques et antiphlogistiques sont erronées; par Mistriss Fulhame. London, Johnson, Robinson and Cadell. Extrait.', in: *Journal de Physique*, (no.61), 1798, vol.3, 392-397.

34. -: *An Essay on Combustion, with a view to a new art of dying and painting. Wherein the phlogistic and antiphlogistic hypotheses are proved erroneous*, London, 1794.

35. Galvani, Luigi: *De viribus electricitatis in motu musculari. Commentarius*, Bologna, 1791.

36. -: *Dell'uso e dell'attività dell'arco conduttore nelle contrazioni dei muscoli*, Bologna, 1794.

37. Gehler, Johann Samuel Traugott: *Physikalisches Wörterbuch oder Versuch einer Erklärung der vornehmsten Begriffe und Kunstwörter der Naturlehre*, 6 vols., Leipzig, 1786-1795.

38. Goethe, Johann Wolfgang: *Werke*, ed. Erich Trunz, 14 vols, (1948-1964), Munich, 1981. (Hamburger-Ausgabe).

39. -: *Werke. Herausgegeben im Auftrage der Grossherzogin Sophie von Sachsen*, 4 parts, 133 vols. in 143 vols., Weimar, 1887-1919. (Weimarer-Ausgabe).

40. -: *Die Schriften zur Naturwissenschaft: Vollständige mit Erläuterungen versehene Ausgabe: herausgegeben im Auftrage der Deutschen Akademie der Naturforscher*, ed. Rupprecht Mathaei et al., Weimar, 1947-. Leopoldina-Ausgabe.

41:- 'Der Versuch als Vermittler von Objekt und Subjekt' in: Michael Böhler, ed., *Schriften zur Naturwissenschaft*, Stuttgart, 1977, 5-15.

42. Göttling, Johann Friedrich August: *Beytrag zur Berichtigung der antiphlogistischen Chemie auf Versuche gegründet*, Jena, 1794.

43. -: 'Neuere Resultate über das Leuchten des Phosphors in verschiedenen Gasarten', in: *Göttlings Taschenbuch für Scheidkünstler und Apotheker*, Jena, 1801, 140-162.

44. Gren, Friedrich Albrecht Carl: *Systematisches Handbuch der gesammten Chemie*, 2 vols., Halle, 1787-90.

45. -: 'Meine letzte Erklärung über die negative Schwere des Phlogistons', in: *Journal der Physik*, 2 (1790), 198-200.

46. -: 'Antwort auf v. Mons, Ueber die Basis der Lebensluft im Quecksilberkalke', in: *Journal der Physik*, 8 (1793), 14-18.

47. -: 'Beschreibung eines sehr zuverlässigen und leicht anwendbaren Eudiometers vom Professor Gren', in: *Neues Journal der Physik*, (no.73), 4 (1797), 363-369.

48. Hales, Stephen: *Vegetable Staticks*, London, 1727.

49. Hauch, Adam Wilhelm von: 'Beschreibung einiger mit Phosphor angestellten Versuche in Hinsicht auf die Wahrscheinlichkeit der Lehre von den Bestandtheilen des Wassers, nemlich Sauerstoff und Wasserstoff', in: *Neues Journal der Physik*, (no.73), 1 (1795), 20-35.

50. Hemsterhuis, Franz: *Oeuvres Philosophiques de M.F. Hemsterhuis*, ed. H.J.Jansen, 2 vols., Paris, 1792.

51. Herder, Johann Gottfried: *Sämtliche Werke*, ed. Bernhard Suphan, 33 vols., Berlin, 1877.

52. :- *Plastik. Einige Wahrnehmungen über Form und Gestalt aus Pygmalions bildenem Traume*, in: *Sämtliche Werke*, 1877, (no. 51), 8, 1-87.

53. Hooke, Robert: *Micrographia*, London, 1665.

54. Humboldt, Friedrich Alexander von: *Versuche über die gereitze Muskel- und Nervenfaser nebst Vermuthungen über den chemischen Proceß des Lebens in der Thier- und Pflanzenwelt*, 2 vols., Posen and Berlin, 1797.

55. -: 'Abhandlung über die dreyfache Verbindung aus Phosphor, Stickstoff und Sauerstoff, oder über das Daseyn der Phosphures d'azote oxides', in: *Allgemeines Journal der Chemie*, (no.5), 1 (1798), 573-589.

56. :- *Essay de Pasigraphie geologique dressée à l'usage de l'Ecole Royale de Mines du Mexique* (1803/1804), in: Hanno Beck, 'Alexander von Humboldts "Essay de Pasigraphie", 1958, (no.136), 35-39.

57. :- *Ideen zu einer Physiognomik der Gewächse*, Stuttgart, 1806.

58. :- *Essai géognostique sur le gisement des roches dans les deux hémisphères*, Paris, 1823.

59. :- *Atlas géographique et physique des régions équinoxiales du Nouveau Continent, fondé sur des observations astronomiques, des mesures trigonométriques et des nivellemens barométriques*, Paris, 1814-1834.

60. :- *Kosmos. Entwurf einer physischen Weltbeschreibung*, 5 vols., Stuttgart: Cotta, 1845-62.

61. *Journal de Physique, de Chemie, d'Histoire Naturelle et des arts, avec des planches en taille-douce*, ed. J.C. Delamétherie, Paris, 1794-1800.

62. Kant, Immanuel: *Gesammelte Schriften*, begonnen von der Königlich Preußischen Akademie der Wissenschaften, 23 vols., Berlin, 1900-1955.

63. Kielmeyer, Carl Friedrich: *Ueber die Verhältniße der organischen Kräfte unter einander in der Reihe der verschiedenen Organisationen, die Geseze und Folgen dieser Verhältniße*, Stuttgart, 1793, in: *Sudhoffs Archiv*, 23 (1930), 247-267.

64. Kirwan, Richard: 'Versuche und Beobachtungen über die spezifische Schwere und die Anziehungskfraft verschiedener Salzarten; und über die neuentdeckte Natur des Phlogistons', in: *Physisch-chemische Werke* (no.66), vol.1, 1783-85 ('Experiments and Observations on the specific Gravities and attractive Powers of various saline Substances', *Philosophical Transactions*, 71 (1781), 1, 7-41; 72 (1782), 2, 179-236; 73 (1783), 1, 15-84).

65. -: 'Versuch über das Phlogiston und die Bestandtheile der Saüren', in: *Physisch-chemische Werke* (no.66), 3 (1788), 233-392 (*Essay on Phlogiston and the Constitution of Acids*, London, 1787).

66. -: *Physisch-chemische Werke*, trans. L. von Crell, 5 vols., Berlin and Stettin, 1783-1801.

67. Lambert, Johann Heinrich: *Neues Organon oder Gedanken über die Erforschung und Bezeichnung des Wahren und dessen Unterscheidung vom Irrthum und Schein*, 2 vols., Leipzig, 1764.

68. Laplace, Pierre Simon de: *Darstellung des Weltsystems durch Peter Simon Laplace. Aus dem Französischen übersezt von Johann Karl Friedrich Hauff*, 2 vols., Frankfurt a. M., 1797.

69. Lavoisier, Antoine Laurent: *Traité élémentaire de Chimie*, Paris, 1789.

70. Leibnitz, Gottfried Wilhelm: *Theodicee, das ist, Versuch von der Güte Gottes, Freyheit des Menschen, und vom Ursprunge des Bösen, bey dieser vierten Ausgabe durchgehends verbessert,*

*auch mit verschiedenen Zusätzen und Anmerkungen vermehrt von Johann Christoph Gottscheden*, Hannover and Leipzig, 1744.

71. Macquer, Pierre Joseph: *Chymisches Wörterbuch*, trans. Johann Gottfried Leonhardi, 2nd revised edition, 7 vols., Leipzig, 1788-1791.

72. Michaelis, Philipp: 'Über die gereizte Muskelfaser, ein Brief an den Herrn Oberbergrath F.A. von Humboldt', in: *Neues Journal der Physik*, (no.73), 4 (1797), 1-27.

73. *Neues Journal der Physik*, ed. Friedrich Albrecht Carl Gren, Leipzig, 1795-.

74. Newton, Sir Issac: *Opticks*, with a preface by Albert Einstein and an introduction by I. Bernhard Cohen, reprint of the fourth edition (1730), New York, 1952.

75. -: *The Correspondence of Issac Newton*, ed. H.W. Turnbull, J.F. Scott, A.R. Hall and L. Tilling, 7 vols., Cambridge, 1959-1977.

76. -: 'Letter to Oldenburg, 18 November' (1676), in: *The Correspondence of Issac Newton*, 1959-1977, (no. 75), vol. 2.

77. -: 'Letter to Roger Cotes, 28 March' (1713), in: *Correspondence of Sir Issac Newton and Professor Cotes*, ed. J. Edelston, Cambridge, 1850, 154-6.

78. Oersted, Hans Christian: *Breve fra og til Hans Christian Oersted, Udgivne af Mathilde Oersted*, 1. Samling, Kopenhagen, 1870.

79. Oken, Lorenz: *Übersicht des Grundrisses des Sistems der Naturfilosofie und der damit entstehenden Theorie der Sinne*, Frankfurt, 1802.

80. :- *Lehrbuch der Naturphilosophie*, 3 vols., Jena, 1809-1811.

81. Pfaff, Christian Heinrich: *Über thierische Elektricität und Reizbarkeit*, Leipzig, 1795.

82. Pico della Mirandola, Giovanni: *De hominis dignitate*, ed. E.Garin, Florence, 1942.

83. Prevost, Benedict: 'Auszug einer Abhandlung des Herrn Ben. Prevost in Genf, über die Ausflüsse riechender Körper, und über die Mittel, sie dem Gesicht bemerkbar zu machen', in: *Neues Journal der Physik*, (no.73), 4 (1797), 242-246.

84. -: 'Fourcroy's Auszug aus einer Abhandlung des Bürgers Benedict Prevost in Genf, Mitgliedes d. Gesells. d. Wissens. u. Künste zu Montanbau, über die Ausflüsse riechender Körper; oder über die odoroscopischen Wirkungen warmer, kalter, riechender und geruchloser Substanzen', in: *Allgemeines Journal der Chemie*, (no.5), 1 (1798), 143-166.

85. -: 'Ueber die odoroskopischen Wirkungen warmer und kalter geruchloser Körper, und über die riechenden Substanzen', in: *Chemische Annalen für die Freunde der Naturlehre*, (no. 19), 1800, 2, 232-254.

86. Priestley, Joseph: *Experiments and Observations on Different Kinds of Air*, 3 vols., London, 1774-77.

87. *Quadratum alchymisticum, das ist: vier auserlesene rare Tractätgen vom Stein der Weisen*, Hamburg, 1705.

88. Quintilian, Marcus Fabius: *Institutio oratoria*, ed. Michael Winterbottom, 2 vols., Oxford, 1970 (Oxford Classical Texts).

89. Reboul, Heinrich: 'Beschreibung eines atmosphärischen Eudiometers von Herrn Heinrich Reboul', in: *Neues Journal der Physik*, (no.73), 1 (1795), 374-379.

90. Reuss, Franz Ambrosius: *Lehrbuch der Mineralogie nach Karstens mineralogischer Tabelle*, 8 vols., Leipzig, 1801-6.

91. Richter, Jeremias Benjamin: *Anfangsgründe der Stöchyometrie oder Meßkunst chemischer Elemente*, 3 vols., Breslau and Hirschberg, 1792-94.

92. Ritter, Johann Wilhelm: *Beweis, daß ein beständiger Galvanismus den Lebensproceß in dem Thierreich begleite*, Weimar: Verlage des Industrie-Comptoirs, 1798.

93. -:, 'Madame Fulhame's Versuche über die Wiederherstellung der Metalle', in: *Allgemeines Journal der Chemie*, (no.5), 1 (1798), 420-444.

94. -: *Beweis, daß der Galvanismus auch in der anorgischen Natur zugegen sey*, in: *Physisch-Chemische Abhandlungen*, (no.98), 1, 139-164.

95. -: 'Versuche und Bemerkungen über den Galvanismus der Voltaischen Batterie', in: *Annalen der Physik*, (no.6), 7 (1800), 431-446; also in: *Physisch-Chemische Abhandlungen*, (no.98), 1, 275-290.

96. -: 'Versuche und Bemerkungen über den Galvanismus der Voltaischen Batterie', in: *Annalen der Physik*, (no.6), 9 (1801), 212-262; also in: *Physisch-Chemische Abhandlungen*, (no.98), 2, 142-189.

97. :- *Das elektrische System der Körper. Ein Versuch*, Leipzig, 1805.

98. -: *Physisch-Chemische Abhandlungen in chronologischer Folge*, 3 vols., Leipzig, 1806.

99. :- *Fragmente aus dem Nachlasse eines jungen Physikers. Ein Taschenbuch für Freunde der Natur*, Heidelberg, 1810. Reprint: Steffen Dietzsch and Birgit Dietzsch eds., Hanau, 1984.

100. :- 'Elektrische Versuche an der Mimosa pudica L. in Parallele mit gleichen Versuche an Fröschen', ed. R.L. Ruhland, in: *Denkschrift der Königlichen Akademie der Wissenschaften zu München für die Jahre 1809/1810*, Munich, 1811.

101. Röschlaub, Andreas: *Untersuchungen über Pathogenie oder Einleitung in die medizinische Theorie*, 3 vols., Frankfurt, 1798-1800.

102.Rumford, Count Benjamin Thompson: 'Versuche und Beobachtungen über die Fortpflanzung der Wärme in Flüssigkeiten', in: *Neues Journal der Physik*, (no.73), 4 (1797) 418-450.

103. Scheele, Carl Wilhelm: *Chemische Abhandlung von der Luft und dem Feuer*, Upsala and Leipzig, 1777 *(Chemical Treatise on Air and Fire)*, in: *Collected Papers of Carl Wilhelm Scheele*, transl. by L. Dobbin, London, 1931.

104. Schelling, Friederich Wilhem Josef: *Friederich Wilhelm Joseph v.Schellings sämtliche Werke*, ed. K.F.A. Schelling, 14 vols. in 2 parts, Stuttgart and Augsburg, 1856-1861.

105. -: *Vom Ich als Princip der Philosophie oder über das Unbedingte im menschlichen Wissen* (1795), in: *Sämtliche Werke*, (no. 104), I, 1, 149-244.

106. -: *Ideen zu einer Philosophie der Natur* (1797), in: *Sämtliche Werke*, (no. 104), I, 2, 1- 343.

107. -: *Von der Weltseele* (1798), in: *Sämtliche Werke*, (no. 104), I, 2, 345-583.

108. -: *Erster Entwurf eines Systems der Naturphilosophie* (1799), in: *Sämtliche Werke*, (no. 104), I, 3, 1-268.

109. -: *Einleitung zu dem Entwurf eines Systems der Naturphilosophie* (1799), in: *Sämtliche Werke*, (no. 104), I, 3, 269-326.

110. -: *System des transcendentalen Idealismus* (1800), in: *Sämtliche Werke*, (no. 104), I, 3, 337-634.

111. -: *Allgemeine Deduktion des dynamischen Processes* (1800), in: *Sämtliche Werke*, (no. 104), I, 4, 1-78.

112. -: *Darstellung meines Systems der Philosophie* (1801), in: *Sämtliche Werke*, (no. 104), I, 4, 105-212.

113. Scherer, Alexander Nicolaus: *Kurze Darstellung der chemischen Untersuchungen der Gasarten*, Weimar, 1799.

114. Smith, William: *A geological section from London to Snowdon showing the varieties of the strata, and the correct altitude of the hills, coloured to correspond with his geological map of England and Wales*, London, 1817.

115. Stahl, Georg Ernst: *Fundamente Chymiae*, Nürnberg, 1723.

116. Steffens, Heinrik: *Beiträge zur innern Naturgeschichte der Erde*, vol.1, Freiberg, 1801.

117. Tiedemann, Dieterich: *Geist der spekulativen Philosophie*, 6 vols., Marburg, 1791-1797.

118. Trebra, Friederich Wilhelm Heinrich von: *Erfahrungen vom Innern der Gebirge nach Beobachtungen gesammelt*, Dessau and Leipzig, 1785.

119. Voigt, Johann Carl Wilhelm: *Practische Gebirgskunde*, Weimar, 1782.

120. :- *Mineralogische Reisen durch das Herzogthum Weimar und Eisenach*, Weimar, 1782.

121. Volta, Alessandro: 'Zweytes Schreiben des Herrn Alexander Volta an den Herausgeber, über die sogenannte thierische Electrizitaet', in: *Neues Journal der Physik*, (no.73), 4 (1797), 107-135.

122. Voltaire: *Lettres Philosophiques*, in Voltaire, *Oeuvres*, Edition Moland, 50 vols., Paris, 1883-1885: vol. 22.

123. Wedel, Georg Wolffgang: *Einleitung zur Alchemie*, Berlin, 1724.

124. Werner, Abraham Gottlob: *Von den äußerlichen Kennzeichen der Foßilien*, Leipzig, 1774.

125. :- *Kurze Klassifikation und Beschreibung der verschiedenen Gebirgsarten*, Dresden, 1787.

126. :- *Ausführliches und systematisches Verzeichnis des Mineralienkabinets des weiland Kurfürstlich-Sächsischen Berghauptmanns Herrn Eugen Pabst von Ohain*, 2 vols., 1791/92, *Freiberg und Annaberg*.

127. Whitehurst, John: *An inquiry into the original state and formation of the earth; deduced from the facts and the laws of Nature. To which is added an appendix, containing some observations on the strata of Derbyshire*, London, 1778.

## *III. Modern sources and criticism*

128. Adler, Jeremy: 'Goethe und Newton. Ansätze zu einer Neuorientierung am Beispiel der chemischen Verwandtschaft', in: *Goethe im Kontext,* (no. 297), 1984, 300-312.

129. :- *"Eine fast magische Anziehungskraft". Goethes 'Wahlverwandtschaften' und die Chemie seiner Zeit*, Munich, 1987.

130. Albury, W.R. and D.R. Oldroyd: 'From Renaissance Mineral Studies to Historical Geology, in the Light of Michel Foucault's *The Order of Things*', in: *British Journal for the History of Science*, 10 (1977), 187-215.

131. Amrine, Frederick, ed.: *Literature and Science as Modes of Expression*, Dordrecht, 1989.

132. Amrine, Frederick, Francis J. Zucker and Harvey Wheeler, eds.: *Goethe and the sciences: a reappraisal*, Dordrecht, 1987.

133. Anderson, W.C.: *Between the Library and the Laboratory: The Language of Chemistry in Eighteenth Century France*, Baltimore, Md., 1984.

134. Arendt, Hannah: *Lectures on Kant's Political Philosophy,* edited and with an interpretative essay by Ronald Beiner, Chicago, 1982.

135. Baumgärtel, Hans: 'Alexander von Humboldt: Remarks on the Meaning of Hypothesis in His Geological Researches', in: Cecil J. Schneer, ed., *Toward a History of Geology*, Cambridge, Mass., 1969, 19-35.

136. Beck, Hanno: 'Alexander von Humboldts "Essay de Pasigraphie", Mexico 1803/04', in: *Forschungen und Fortschritte* 32 (1958), Heft 2, 33-39.

137. :- 'Alexander von Humboldts Beitrag zur Kartographie', in: *Alexander von Humboldt. Leben und Werk*, 1985, (no. 193), 239-248.

138. Beer, Gillian: *Darwin's Plots: Evolutionary Narrative in Darwin, George Eliot, and Nineteenth Century Fiction*, London, 1983.

139. :- 'Discourses of the Island', in: *Literature and Science as Modes of Expression*, 1989, (no. 131), 1-27.

140. :- 'Helmholtz, Tyndall, Gerald Manley Hopkins: leaps of the prepared imagination', in: *Comparative Criticism*, 13 (1991), (no. 281), 117-145.

141. Behler, Ernst and Jochen Hörisch, eds.: *Die Aktualität der Frühromantik*, Paderborn, 1987.

142. Berg, Hermann and Klaus Richter: *Entdeckungen zur Elektrochemie, Bioelektrochemie und Photochemie. Von Johann Wilhelm Ritter*, (Ostwalds Klassiker der exakten Wissenschaften, vol. 271), Leipzig, 1986.

143. Böhler, Michael: 'Naturwissenschaft und Dichtung bei Goethe', in: *Goethe im Kontext*, (no. 297), 1984, 313-335.

144. Böhme, Gernot: 'Is Goethe's Theory of Color Science?', in: *Goethe and the sciences: a reappraisal*, 1987, (no. 132), 147-173.

145. :- ed., *Klassiker der Naturphilosophie: von den Vorsokratikern bis zur Kopenhagener Schule*, Munich, 1989.

146. Bowen, Margarita: *Empiricism and geographical thought. From Francis Bacon to Alexander von Humboldt*, Cambridge, 1981.

147. Broman, Thomas H.: 'J.C. Reil and the "Journalization" of Physiology', in: *The Literary Structure of Scientific Argument*, 1991, (no. 160), 13-42.

148. Buchler, Justus: *Toward a General Theory of Human Judgement*, New York, 1951.

149. Bynum, W.F. and Roy Porter, eds.: *Brunonianism in Britain and Europe*, Medical History, Supplement No. 8, London, 1988.

150. Cantor, Geoffrey N: 'The rhetoric of experiment', in: *The uses of experiment*, Cambridge, 1989, (no. 177), 159-180.

151. Cantor, Geoffrey. N., and Michael Hodge: *Conceptions of ether. Studies in the history of ether theories 1740-1900*, Cambridge, 1981.

152. Cassirer, Ernst: *Das Erkenntnisproblem in der Philosophie und Wissenschaft der neueren Zeit*, 2 vols., Darmstadt, 1974.

153. Clarke, Edwin, and L.S. Jacyna: *Nineteenth-Century Origins of Neuroscientific Concepts*, Berkeley, Los Angeles and London, 1989.

154. Cohen, I. Bernard: *Franklin and Newton*, Memoirs of the American Philosophical Society, vol. 43, Philadelphia, 1956.

155. Collins, H.M.: *Changing Order: Replication and Induction in Scientific Practice*, London and Beverly Hills: Sage, 1985.

156. :- 'The meaning of experiment: replication and reasonableness', in: H. Lawson and L. Appignanesi, eds., *Dismantling Truth: Reality in the Post-Modern World*, London, 1989, 82-92.

157. Couturat, Louis: *La logique de Leibniz*, Paris, 1901.

158. Crosland, Maurice P.: *Historical Studies in the Language of Chemistry*, London, 1962.

159. Cunningham, Andrew, and Nicholas Jardine, eds.: *Romanticism and the sciences*, Cambridge, 1990.

160. Dear, Peter, ed.: *The Literary Structure of Scientific Argument. Historical Studies*, Philadelphia, 1991.

161. :- 'Narratives, Anecdotes, and Experiments: Turning Experience into Science in the Seventeenth Century', in: *The Literary Structure of Scientific Argument*, 1991, (no. 160), 135-163.

162. *Der Kleine Pauly. Lexicon der Antike*, eds. Konrat Ziegler, Walther Sontheimer and Hans Gärtner, 5 vols., Munich, 1979.

163. Dobbs, Betty Jo Teeter: *The Foundations of Newton's Alchemy*, Cambridge, 1975.

164. Durner, Manfred: 'Die Rezeption der zeitgenössischen Chemie in Schellings früher Naturphilosophie', in: *Natur und Subjektivität*, 1985, (no. 188), 15-38.

165. - : 'Die Naturphilosophie im 18. Jahrhundert und der naturwissenschaftliche Unterricht in Tübingen. Zu den Quellen von Schellings Naturphilosophie', in: *Archiv für Geschichte der Philosophie*, 73 (1991), Heft 1, 71-103.

166. Düsing, Klaus: 'Teleologie der Natur. Eine Kant-Interpretation mit Ausblicken auf Schelling', in: *Natur und Subjektivität*, 1985, (no. 188), 187-210.

167. Engelhardt, Dietrich von: *Hegel und die Chemie. Studie zur Philosophie und Wissenschaft der Natur um 1800*, Schriften zur Wissenschaftsgeschichte 1, Wiesbaden, 1976.

168. :- 'Historical consciousness in the German Romantic *Naturforschung*', trans. Christine Salazar, in: *Romanticism and the sciences*, 1990, (no. 159), 55-68.

169. Engelhardt, Wolf von, and Dorothea Kuhn: 'Johann Wolfgang Goethe (1749-1832)', in: *Klassiker der Naturphilosophie*, 1989, (no. 145), 220-240.

170. Frank, Manfred: *Eine Einführung in Schellings Philosophie*, Frankfurt am Main, 1985.

170a. :- *What is Neostructuralism?*, trans. Sabine Wilke and Richard Gray, Minneapolis, 1989.

171. French, Roger K.: 'Ether and physiology', in: *Conceptions of ether*, 1981, (no.151), 111-134.

172. Fritscher, Bernhard: *Vulkanismusstreit und Geochemie. Die Bedeutung der Chemie und des Experiments in der Vulkanismus-Neptunismus-Kontroverse*, Stuttgart, 1991.

173. :- 'A.G.Werner (1749-1817) als Lehrer der deutschen Naturphilosophie - Zum Werk von Henrik Steffens (1773-1845)', in: *Zeitschrift für geologische Wissenschaften*, 21 (5/6) (1993), 495-502.

174. Gilbert, G.N. and M. Mulkay: *Opening Pandora's Box: A Sociological Analysis of Scientists' Discourse*, Cambridge, 1984.

175. Gode-von Aesch, Alexander: *Natural Science in German Romanticism*, Columbia University Germanic Studies vol. 11, New York, 1941 (reprint 1966).

176. Gooding, David: ''Magnetic curves' and the magnetic field: experimentation and representation in the history of a theory', in: *The uses of experiment*, 1989, (no.177), 183-223.

177. Gooding, David, Trevor Pinch, and Simon Schaffer, eds.: *The uses of experiment*, Cambridge, 1989.

178. Göranzon, Bo: 'The Practice of the Use of Computers. A Paradoxical Encounter between Different Traditions of Knowledge', in: Bo Göranzon and Ingela Josefson, eds., *Knowledge, Skill and Artificial Intelligence*, Heidelberg: Springer-Verlag, 1988, 9-18.

179. Göranzon, Bo, and Magnus Florin, eds.: *Artificial Intelligence, Culture and Language: On Education and Work*, Heidelberg: Springer-Verlag, 1990.

180. Gower, Barry: 'Speculation in Physics: The History and Practice of *Naturphilosophie*', in: *Studies in the History and Philosophy of Science*, **3**, 1973, 301-56.

181. Guntau, Martin: *Abraham Gottlob Werner*, Biographien hervorragender Naturwissenschaftler, Techniker und Mediziner vol. 75, Leipzig, 1984.

182. Halliburton, David: 'Reconstructing theory', in: *Comparative Criticism*, 11 (1990), (no. 280), 71-95.

183. Handwerker, Gary: 'Romantic irony: the comparative history of European literature', in: *Comparative Criticism* 15 (1993), (no. 283), 279-283.

184. Hannaway, O.: *The Chemists and the Word: The Didactic Origins of Chemistry*, Baltimore, Md., 1975.

185. Harré, Rom: *Great Scientific Experiments*, Oxford, 1981.

186. -: ed., *The physical sciences since antiquity*, London and Sydney, 1986.

187. Harrison, Bernard: 'Deconstructing Derrida', in: *Comparative Criticism*, 11 (1990), (no. 280), 3-24.

188. Heckmann, Reinhard, Hermann Krings and Rudolf W. Meyer, eds.: *Natur und Subjektivität: zur Auseinandersetzung mit der Naturphilosophie des jungen Schelling*, Stuttgart-Bad Cannstatt , 1985.

189. Heckmann, Reinhard: 'Natur - Geist - Identität. Die Aktualität von Schellings Naturphilosophie im Hinblick auf das moderne evolutionäre Weltbild', in: *Natur und Subjektivität*, 1985, (no. 188), 291-344.

190. Hegge, Hjalmar: 'Theory of Science in the Light of Goethe's Science of Nature', in: *Goethe and the sciences: a reappraisal*, 1987, (no. 132), 195-218.

191. Heilbron, J.L.: *Electricity in the 17th and 18th Centuries. A Study of Early Modern Physics*, Berkeley, Los Angeles and London, 1979.

192. Heimann, P. and J.E. McGuire: 'Newtonian forces and Lockean powers: concepts of matter in eighteenth-century thought', in: *Historical Studies in Physical Science*, 3 (1971), 233-306.

193. Hein, Wolfgang-Hagen, ed.: *Alexander von Humboldt. Leben und Werk*, Frankfurt am Main, 1985.

194. Hermann, Armin: *Die Begründung der Elektrochemie und Entdeckung der ultravioletten Strahlen von Johann Wilhelm Ritter. Eine Auswahl aus den Schriften des romantischen Physikers*, Ostwalds Klassiker der exakten Wissenschaften, new series, vol. 2, Frankfurt am M., 1968.

195. Herwig, Henriette: 'On open and closed doors, or how dead is the sign? On Kafka, Peirce and Derrida', in: *Comparative Criticism*, 14 (1992), (no. 282), 87-110.

196. Hesse, Mary: *Models and Analogies in Science*, Notre Dame, 1963 (reprinted and revised, 1966).

197. Hildebrandt, Karl: *Goethes Naturerkenntnis*, Hamburg, 1949.

198. Hofbauer, Gottfried: 'Die sinnliche Naturgeschichte des Abraham Gottlob Werner. An der Grenze zwischen Empirismus und romantischer Naturphilosophie', in: *Zeitschrift für geologische Wissenschaften*, 21 (5/6) (1993), Berlin, 545-558.

199. Höffe, Otfried: *Immanuel Kant*, Munich, 1988.

200. Hölder, Helmut: *Geologie und Paläontologie in Texten und ihrer Geschichte*, Freiburg and Munich, 1960.

201. Holmyard, Eric John: *Alchemy*, 1957, Dover reprint, New York, 1990.

202. Hüffmeier-von Hagen, Dorothee: 'J.W. Ritter und die Anfänge der Elektrophysiologie', in: K.E.Rothschuh, ed., *Von Boerhaave bis Berger. Die Entwicklung der kontinentalen Physiologie im 18. und 19. Jahrhundert mit besonderer Berücksichtigung der Neurophysiologie*, Stuttgart, 1964, 48-61.

203. Hussey, Edward: 'Matter Theory in Ancient Greece', in: *The physical sciences since antiquity*, 1986, (no.186), 10-28.

204. Jacob, James R.: *Robert Boyle and the English Revolution: A Study in Social and Intellectual Change*, New York, 1977

205. Jacob, Margaret C.: *The Newtonians and the English Revolution 1689-1720*, Hassocks, Sussex, 1976.

206. :- 'Newtonian science and the radical Enlightenment', in: *Vistas in Astronomy*, 22 (1979), 545-555.

207. Jacobs, Wilhelm G.: 'Geschichte und Kunst in Schellings "System des transscendentalen Idealismus"', in: Walter Jaeschke and Helmut Holzhey, eds., *Früher Idealismus und Frühromantik. Der Streit um die Grundlagen der Ästhetik (1795-1805)*, Hamburg, 1990, 201-213.

208. Janik, Allan: 'Tacit Knowledge, Rule-following and Learning', in: *Artificial Intelligence, Culture and Language: On Education and Work*, 1990 (no. 179), 45-55.

209. Jardine, Nicholas: *The fortunes of inquiry*, Oxford, 1986.

210:- *The scenes of inquiry*, Oxford, 1991.

211. Jonsen, Albert R. and Stephen Toulmin: *The Abuse of Casuistry. A History of Moral Reasoning*, Berkeley, Los Angeles and London: University of California Press, 1988.

212. Keiling, Karl: 'Über die Sympathie bei Plotin', Dissertation, Universität Jena, Weida i. Th., 1916.

213. Kleinschnieder, Manfred: *Goethes Naturstudien. Wissenschaftstheoretische und -geschichtliche Untersuchungen*, Abhandlungen zur Philosophie, Psychologie und Pädagogik vol.75, Bonn, 1971.

214. Klemm, Friedrich and Armin Hermann, eds.: *Briefe eines romantischen Physikers. Johann Wilhelm Ritter an Gotthilf Heinrich Schubert und an Karl von Hardenberg*, Munich, 1966.

215. Knight, David: 'The Heroic age of Chemistry', in: *The physical sciences since antiquity*, 1986, (no.186), 78-95.

216. -: 'Physics and chemistry in the modern era', in: *The physical sciences since antiquity*, 1986, (no.186), 113-122.

217. Knoespel, Kenneth J.: 'The Mythological Transformations of Renaissance Science: Physical Allegory and the Crisis of Alchemical Narrative', in: *Literature and Science as Modes of Expression*, 1989, (no. 131), 99-112.

218. Koch, Franz: *Goethe und Plotin*, Leipzig, 1925.

219. :- *Goethes Gedankenform*, Berlin 1967.

220. Koyré, Alexander: *Newtonian Studies*, London, 1965.

221. Krings, Hermann: 'Natur als Subjekt. Ein Grundzug der spekulativen Physik Schellings', in: *Natur und Subjektivität*, 1985, (no. 188), 111-128.

222. Kubrin, David: 'Newton and the cyclical cosmos: providence and the mechanical philosophy', in: *Journal of the History of Ideas*, 28 (1967), 325-346.

223. Kuhn, Dorothea: 'Goethe und die Chemie', in: *Medizinhistorisches Journal*, 7 (1972), 264-278.

224. Kuhn, Thomas S.: *The Structure of Scientific Revolutions*, Chicago, 1970.

225. Kuhn-Schnyder, Emil: *Lorenz Oken (1779-1851). Erster Rektor der Universität Zurich. Mit Beiträgen von Peter G. Waser und Heinz Balmer*, Zurich, 1980.

226. Kümmerl, Werner Friedrich: 'Alexander von Humboldt und die Medizin', in: *Alexander von Humboldt. Leben und Werk*, 1985, (no. 193), 195-210.

227. Lakatos, Imre: 'Newton's effect on scientific standards', in: *Philosophical Papers*, vol. 1, *The methodology of scientific research programmes*, Cambridge, 1978, 193-222.

228. Latour, Bruno: *Science in Action: How to Follow Scientists and Engineers through Society*, Milton Keynes, 1987.

229. :- *The Pasteurization of France*, trans. A. Sheridan, Harvard, 1988.

230. Latour, Bruno and Steve Woolgar: *Laboratory Life: The Construction of Scientific Facts*, Beverly Hills, California, 1979.

231. Laudan, Rachel: *From Mineralogy to Geology. The Foundations of a Science, 1650-1830*, Chicago and London, 1987.

232. Lauth, Reinhard: *Die transzendentale Naturlehre Fichtes nach den Prinzipien der Wissenschaftslehre*, Hamburg, 1984.

233. Lawrence, Christopher: 'Cullen, Brown and the poverty of essentialism', in: *Brunonianism in Britain and Europe*, 1988, (no.149), 1-21.

234. Laymon, Ronald: 'Newton's *experimentum crucis* and the logic of idealization and theory refutation', in: *Studies in History of Philosophy of Science*, 9 (1958), 51-77.

235. Lenoir, Timothy: 'Morphotypes and the historical-genetic method in Romantic biology', in: *Romanticism and the sciences*, 1990, (no. 159), 119-129.

236. Lohne, Johannes A.: 'Experimentum crucis', in: *Notes and Records of the Royal Society of London 23* (1968), 169-199.

237. Losee, John: *A Historical Introduction to the Philosophy of Science*, Oxford, 1972.

238. Lovejoy, Arthur O.: *The Great Chain of Being. A Study of the History of an Idea*, Cambridge, Mass., 1936 (reprint 1957).

239. Manuel, Frank E.: *A Portrait of Issac Newton*, Cambridge, Mass., 1968.

240. McGuire, J.E. and P.M. Rattansi: 'Newton and the Pipes of Pan', in: *Notes and Records of the Royal Society*, 21 (1966), 108-143.

241. McMullin, Ernan: *Newton on Matter and Activity*, Notre Dame, Indiana, and London, 1978.

242. Meyer, Rudolf W.: 'Zum Begriff der spekulativen Physik bei Schelling', in: *Natur und Subjektivität*, 1985, (no. 188), 129-155.

243. Meyer-Abich, Adolf: *Die Vollendung der Morphologie Goethes durch Alexander von Humboldt. Ein Beitrag zur Naturwissenschaft der Goethezeit*, Göttingen, 1970.

244. Morgan, Sue: 'Schelling and the origins of his *Naturphilosophie*', in: *Romanticism and the sciences*, 1990, (no. 159), 25-37.

245. Moser, Walter: 'Experiment and Fiction', in: *Literature and Science as Modes of Expression*, 1989, (no. 131), 61-80.

246. Neubauer, John: 'Literature and Science: Future Possibilities', in: *University of Hartford Studies in Literature*, 19 (1987), 53-57.

247. Nicholson, Malcolm: 'Alexander von Humboldt and the geography of vegetation', in: *Romanticism and the sciences*, 1990, (no. 159), 169-185.

248. Nickles, Thomas: 'Justification and experiment', in: *The uses of experiment*, 1989, (no. 177), 299-333.

249. Nisbet, H.B.: *Goethe and the Scientific Tradition*, Publications of the Institute of Germanic Studies vol. 14, London, 1972.

250. Nordenstam, Tore: 'Language and Action', in: *Artificial Intelligence, Culture and Language: On Education and Work*, 1990, (no. 179), 61-70.

251. Ospovat, Alexander M.: 'Romanticism and German Geology', in: *Eighteenth-Century Life*, 7 (1982), 105-117.

252. Partington, James Riddick: *A Short History of Chemistry*, 3rd edition, 1957. Dover reprint, New York, 1989.

253. -: *A History of Chemistry*, 4 vols., London, 1961-1970.

254. Pickering, Andy: 'Living in the material world', in: *The uses of experiment*, 1989, (no.177), 275-297.

255. Podro, M.: *The Manifold in Perception*, Oxford, 1972.

256. Polanyi, Michael: *Knowing and Being*, ed. by M. Grene, Chicago, 1969.

257. Porter, Roy: 'A new discipline? Essays in 'literature and science'', in: *Comparative Criticism*, 13 (1991), (no. 281), 273-276.

258. Poser, Hans: 'Spekulative Physik und Erfahrung. Zum Verhältnis von Experiment und Theorie in Schellings Naturphilosophie', in: Ludwig Hasler, ed., *Schelling: seine Bedeutung für eine Philosophie der Natur und der Geschichte*, Stuttgart-Bad Cannstatt: frommann-holzboog, 1981, 129-138.

259. Pross, Wolfgang: 'Lorenz Oken - Naturforschung zwischen Naturphilosophie und Naturwissenschaft', in: Nicholas Saul, ed., *Die deutsche literarische Romantik und die Wissenschaften*, Publications of the Institute of Germanic Studies (University of London) vol. 47, Munich, 1991, 44-71.

260. Rehbock, Philip F.: 'Transcendental anatomy', in: *Romanticism and the sciences*, 1990, (no. 159), 144-160.

261. Richter, Klaus, ed.: *Der Physiker des Romantikerkreises Johann Wilhelm Ritter in seinen Briefen an den Verleger Carl Friedrich Ernst Fromann*, Weimar, 1988.

262. Risse, Guenter B.: 'Kant, Schelling and the early search for a philosophical "science" of medicine in Germany', in: *Journal of the History of Medicine*, 27 (1972), 145-158.

263. -: '"Philosophical" medicine in nineteenth-century Germany: an episode in the relation between philosophy and medicine', in: *Journal of Medicine and Philosophy*, 1 (1976), 72-91.

264. --: 'Brunonian therapeutics: new wine in old bottles?', in: *Brunonianism in Britain and Europe*, 1988, (no.149), 46-62.

265. Ritterbush, P.C.: *Overtures to biology. The speculations of eighteenth-century naturalists*, New Haven and London, 1964.

266. Rousseau, George Sebastian: 'Discourses of the Nerve', in: *Literature and Science as Modes of Expression*, 1989, (no. 131), 29-60.

267. Rousseau, George Sebastian, and Roy Porter, eds.: *The Ferment of Knowledge: Studies in the Historiography of Eighteenth-Century Science*, Cambridge, 1980.

268. Rudwick, Martin J.: 'The emergence of a visual language for geological science, 1760-1840', in: *History of Science*, 14 (1976), 149-195.

269. Rupke, Nicolas A.: 'Caves, fossils and the history of the earth', in: *Romanticism and the sciences*, 1990, (no. 159), 241-259.

270. Schaffer, Simon: 'Glass works: Newton's prisms and the uses of experiment', in: *The uses of experiment*, 1989, (no. 177), 67-104.

271. :- 'Genius in Romantic natural philosophy', in: *Romanticism and the sciences*, 1990, (no. 159), 82-98.

272. Schimank, Hans: 'J.W.Ritter, der Begründer der wissenschaftlichen Elektrochemie. Ein Lebensbild aus dem Zeitalter der Romantik', in: *Abhandlungen und Berichte des Deutschen Museums*, 5 (1933), 175-203.

273. Schmied-Kowarzik, Wolfdietrich: 'Friedrich Wilhelm Joseph Schelling. 1775-1854', in: *Klassiker der Naturphilosophie,* 1989, (no. 145), 241-262.

274. -: 'Thesen zur Entstehung und Begründung der Naturphilosophie Schellings', in: Karen Gloy and Paul Burger, eds., *Die Naturphilosophie im Deutschen Idealismus*, Stuttgart-Bad Cannstatt: frommann-holzboog, 1993, 67-100.

275. Schon, Donald A.: *Displacement of Concepts*, London, 1963.

276. Sepper, Dennis: *Goethe contra Newton. Polemics and the project for a new science of color*, Cambridge, 1988.

277. Shaffer, Elinor S., ed.: *Comparative Criticism*, 7 (1985).

278. :- 'Literature and Science: Toward a New Literary History', in: *University of Hartford Studies in Literature*, 19 (1987), 37-52.

279:- 'Romantic philosophy and the organization of the disciplines: the founding of the Humboldt University in Berlin', in: *Romanticism and the sciences*, 1990, (no. 159), 38-54.

280. :- ed., *Comparative Criticism*, 11 (1990).

281. :- ed., *Comparative Criticism*, 13 (1991).

282. :- ed., *Comparative Criticism*, 14 (1992).

283. :- ed., *Comparative Criticism*, 15 (1993).

284. Shapin, Steven: 'Social uses of science', in: *The Ferment of Knowledge,* 1980, (no. 267), 93-139.

285. :- 'Pump and circumstance: Robert Boyle's literary technology', in: *Social Studies of Science*, 14 (1984), 481-520.

286. Shapin, Steven and Simon Schaffer: *Leviathan and the Air-Pump: Hobbes, Boyle and the Experimental Life*, Princeton, 1985.

287. Taylor, Charles: 'Philosophical gadfly. The original Socrates and Plato's version', in: *Times Literary Supplement*, June 7 1991, 3-4.

288. Tsouyopoulos, Nelly: 'The influence of John Brown's ideas in Germany', in: *Brunonianism in Britain and Europe*, 1988, (no.149), 63-74.

289. Wagenbreth, Otfried: 'Abraham Gottlob Werners System der Geologie, Petrographie und Lagerstätten Lehre', in: *Abraham Gottlob Werner Gedenkenschrift, Freiberger Forschungsheft*, C 223, Leipzig, 1967, 83-148.

290. :- 'Werner-Schüler als Geologen und Bergleute', in: *Abraham Gottlob Werner Gedenkenschrift, Freiberger Forschungsheft*, C 223, Leipzig, 1967, 163-178.

291. Wetzels, Walter D.: *Johann Wilhelm Ritter: Physik im Wirkungsfeld der deutschen Romantik*, Berlin and New York, 1973.

292. -: 'Johann Wilhelm Ritter: Romantic physics in Germany', in: *Romanticism and the sciences*, 1990, (no. 159), 199-212.

293. Wilde, Christopher B.: 'Hutchinsonianism, natural philosophy and religious controversy in eighteenth century Britain', in: *History of Science*, 18 (1980), 1-24.

293a. Wilkinson, Elizabeth M.: ''Tasso - ein gesteigerter Werther' in the light of Goethe's principle of 'Steigerung'', in: E.M. Wilkinson and L.A. Willoughby, *Goethe. Poet and Thinker*, London, 1962, 185-213.

294. Wilkinson, Elizabeth. M. and L.A. Willoughby: 'The Blind Man and the Poet. An Early Stage in Goethe's Quest for Form', in: *German Studies presented to Walter Horace Bruford*, London, 1962, 29-57.

295. Williams, L.Pearce: 'The Physical Sciences in the First Half of the Nineteenth Century: Problems and Sources', in: *History of Science. An Annual Review of Literature, Research and Teaching*, 1 (1962), Cambridge, 1-15.

296. Wittgenstein, Ludwig: *Philosophical investigations*, Blackwell, Oxford, 1953.

297. Wittkowski, Wolfgang, ed.: *Goethe im Kontext. Kunst und Humanität, Naturwissenschaft und Politik von der Aufklärung bis zur Restauration*, Tübingen: Max Niemeyer Verlag, 1984.

298. Yates, Frances Amelia: *Giordano Bruno and the Hermetic Tradition*, London and Chicago, 1964.

299. -: *The Art of Memory*, London, 1966.

300. -: *Ideas and Ideals in the North European Renaissance*, in: F.A. Yates, *Collected Essays*, vol.3, London, Boston, Melbourne, 1984.

301. Zajonc, Arthur G.: 'Facts as Theory: Aspects of Goethe's Philosophy of Science', in: *Goethe and the sciences: a reappraisal*, 1987, (no. 132), 219-245.

302. Ziman, John: *Reliable Knowledge*, Cambridge, 1978.

303. Ziolkowski, Theodore: *German Romanticism and Its Institutions*, Princeton, 1990.

304. Zukav, Gary: *The Dancing Wu-Li Masters*, New York, 1979.

## *IV. Secondary literature on Novalis*


305. Beck, Hans-Joachim: *Friederich von Hardenbergs 'Oeconomie des Styls'. Die 'Wilhelm-Meister'-Rezeption im 'Heinrich von Ofterdingen'*, Bonn, 1976.

306. Burwick, Frederick: *The Damnation of Newton: Goethe's Color Theory and Romantic Perception*, Berlin and New York, 1986.

307. Cardinal, Roger: 'Werner, Novalis and the Signature of Stones', in: *Deutung und Bedeutung. Studies in German and Comparative Literature. Presented to Karl-Werner Maurer*, The Hague and Paris, 1973, 118-133.

308. Clark, Karin P.: 'Das Bild des Wassers bei Novalis im Spiegel seiner naturwissenschaftlichen und philosophischen Fragmente', Diss., University of Cincinatti, 1975.

309. Dick, Manfred: *Die Entwicklung des Gedankens der Poesie in den Fragmenten des Novalis*, Bonn, 1967.

310. Dilthey, Wilhelm: *Das Erlebnis und die Dichtung. Lessing - Goethe - Novalis - Hölderlin*, Göttingen, 1965.

311. Dyck, Martin: *Novalis and Mathematics*, Chapel Hill, 1960.

312. Frank, Manfred: 'Die Philosophie des sogenannten 'magischen Idealismus'', in: *Euphorion*, 63 (1969), 88-116.

313. :- *Das Problem der 'Zeit' in der deutschen Romantik*, Munich, 1972.

314. :- ''Intellektuale Anschauung'. Drei Stellungnahmen zu einem Deutungsversuch von Selbstbewußtsein: Kant, Fichte, Hölderlin/Novalis', in: *Die Aktualität der Frühromantik*, 1987, (no. 141), 96-126.

315. Frank, Manfred and Gerhard Kurz: 'Ordo inversus. Zu einer Reflexionsfigur bei Novalis, Hölderlin, Kleist und Kafka', in: Herbert Anton, Berhard Gajek and Peter Pfaff, eds., *Geist und Zeichen. Festschrift für Arthur Henkel*, Heidelberg, 1977, 75-92.

316. Gaier, Ulrich: *Krumme Regel: Novalis' 'Konstruktionslehre des schaffenden Geistes' und ihre Tradition*, Untersuchungen zur deutschen Literaturgeschichte 4, Tübingen, 1970.

317. Haering, Theodor: *Novalis als Philosoph*, Stuttgart, 1954.

318. Hamburger, Käte: 'Novalis und die Mathematik. Eine Studie zur Erkenntnistheorie der Romantik', in: *Romantik-Forschungen*, Halle, 1929, 113-184.

319. Hansen, Erk F.: *Wissenschaftswahrnehmung und -umsetzung im Kontext der deutschen Frühromantik. Zeitgenössische Naturwissenchaft und Philosophie im Werk Friedrich von Hardenbergs (Novalis)*, Frankfurt am Main, 1993.

320. Hegener, Johannes: *Die Poetisierung der Wissenschaften bei Novalis, dargestellt am Prozeß der Entwicklung von Welt und Menschheit. Studien zum Problem des enzyklopädischen Welterfahrens*, Bonn, 1975.

321. Jacobs, Jürgen: *Wilhelm Meister und seine Brüder. Untersuchungen zum deutschen Bildungsroman*, Munich, 1972.

322. Kapitza, Peter: *Die frühromantische Theorie der Mischung. Über den Zusammenhang von romantischer Dichtungstheorie und zeitgenössischer Chemie*, Münchener Germanistische Beiträge 4, Munich, 1968.

323. Kluckhohn, Paul: *Das Ideengut der Romantik*, Tübingen, 1941

324. Köhn, Lothar: *Entwicklungs- und Bildungsroman. Ein Forschungsbericht*, Stuttgart, 1969.

325. Kuzniar, Alice A.: *Delayed Endings. Nonclosure in Novalis and Hölderlin*, Athens, Georgia, 1986.

326. Löffler, Dietrich: 'Berufserfahrung und Theoriebildung bei Friedrich von Hardenberg (Novalis)', in: Dietrich Löffler and Dieter Bähtz, eds., *Interkurs. Internationaler Hochschulferienkurs für Germanistik der Martin-Luther-Universität Halle-Wittenberg. Reden und Vorträge*, (Martin-Luther-Universität Halle-Wittenberg. Wissenschaftliche Beiträge 1978, vol. 22), Halle, 1978, 39-67.

327. Lohse, Nikolaus: *Dichtung und Theorie. Der Entwurf einer dichterischen Transzendentalpoetik in den Fragmenten des Novalis*, Heidelberg, 1988.

328. Lukács, Georg: *Die Theorie des Romans. Ein geschichtsphilosophischer Versuch über die Formen der großen Epik*, Berlin, 1920. Reprint, Berlin, 1971.

329. Mähl, Hans-Joachim: 'Eine unveröffentliche Kant-Studie des Novalis', in: *Deutsche Vierteljahrsschrift für Literaturwissenschaft und Geistesgeschichte*, 36 (1962), 36-68.

330. -: 'Novalis und Plotin. Untersuchungen zu einer neuen Edition und Interpretation des 'Allgemeinen Brouillon'', in: *Jahrbuch des freien deutschen Hochstifts*, 1963, 139-250.

331. :- *Die Idee des goldenen Zeitalters im Werk des Novalis. Studien zur Wesensbestimmung der frühromantischen Utopie und zu ihren ideengeschichtlichen Voraussetzungen*, Heidelberg, 1965.

332. Mahoney, Dennis F.: *Die Poetisierung der Natur bei Novalis*, Bonn, 1980.

333. Molnár, Géza von: 'Another Glance at Novalis' 'Blue Flower'', in: *Euphorion*, 67 (1973), 272-286.

334. -: *Novalis' "Fichte Studies". The Foundations of his Aesthetics*, The Hague, Paris, 1970.

335. :- *Romantic Vision, Ethical Context: Novalis and Artistic Autonomy*, Minneapolis, 1987.

336. :- '"What Ever Happened to Ethics?"', in: *Literature and Science as Modes of Expression*, 1989, (no. 131), 113-127.

337. Neubauer, John: *Bifocal Vision. Novalis' Philosophy of Nature and Disease*, Chapel Hill, 1971.

338. :- 'Intellektuelle, intellektuale und ästhetische Anschauung. Zur Entstehung der romantischen Kunstauffassung', in: *Deutsche Vierteljahrsschrift für Literaturwissenschaft und Geistesgeschichte*, 46 (1972), 294-319.

339. -: *Symbolismus und symbolische Logik: Die Idee der 'ars combinatoria' in der Entwicklung der modernen Dichtung*, Munich, 1978.

340. :- 'Nature as Construct', in: *Literature and Science as Modes of Expression*, 1989, (no. 131), 129-140.

341. Olshausen, Waldemar: *Friederich von Hardenbergs (Novalis) Beziehungen zur Naturwissenchaft seiner Zeit*, Leipzig, 1905.

342. Pixburg, Hermann: *Novalis als Naturphilosoph*, Gütersloh, 1928

343. Reiss, Hans: *Politisches Denken in der deutschen Romantik*, Bern, Munich, 1966.

344. Samuel, Richard: 'Der berufliche Werdegang Friederich von Hardenbergs', in: *Romantik-Forschungen*, Halle, 1929, 83-112.

345. Saul, Nicholas: 'Novalis' "Geistige Gegenwart" and his Essay "Die Christenheit oder Europa"', in: *Modern Language Review* 77 (1982), 361-377.

346. :- *History and Poetry in Novalis and in the Tradition of the German Enlightenment*, Bithell Series of Dissertations, vol. 8, London, 1984.

347. Schipperges, Heinrich: 'Krankwerden und Gesundsein bei Novalis', in: Richard Brinkmann, ed., *Romantik in Deutschland. Ein interdisziplinäres Symposion*, (Sonderband der *Deutschen Vierteljahrsschrift für Literaturwissenschaft und Geistesgeschichte*), Stuttgart, 1978, 226-242.

348. Schmid, Hans Dieter: 'Friedrich von Hardenberg und Abraham Gottlob Werner', Diss. phil., Tübingen, 1951.

349. Schulz, Gerhard: 'Die Berufstätigkeit Friederich von Hardenbergs und ihre Bedeutung für seine Dichtung und seine Gedankenwelt', Diss., Leipzig, 1958.

350. Sohni, Hans: *Die Medizin der Frühromantik. Novalis' Bedeutung für den Versuch einer Umwertung der 'Romantischen Medizin'*, Freiburg i.Br, 1973.

351. Stadler, Ulrich: 'Novalis: "Heinrich von Ofterdingen" (1802)', in: Paul Michael Lützeler, ed., *Romane und Erzählungen der deutschen Romantik. Neue Interpretationen*, Stuttgart, 1981, 141-162.

352. :- 'Hardenbergs "poetische Theorie der Fernröhre". Der Synkretismus von Philosophie und Poesie, Natur- und Geisteswissenschaften und seine Konsequenzen für eine Hermeneutik bei Novalis', in: *Die Aktualität der Frühromantik*, 1987, (no. 141), 51-62.

353. Striedter, Jury: *Die Fragmente des Novalis als 'Präfigurationen' seiner Dichtung*, Munich, 1985.

354. Uerlings, Herbert: *Friederich von Hardenberg, genannt Novalis. Werk und Forschung*, Stuttgart, 1991.

355. Wagner, Lydia Elisabeth: *The Scientific Interests of Friederich von Hardenberg*, Ann Arbor, 1937.

356. Wetzels, Walter D.: 'Klingsohrs Märchen als Science Fiction', in: *Monatshefte*, 65, No.2 (1973), 167-175.

357. White, John J.: 'Novalis's *Heinrich von Ofterdingen* and the Aesthetics of 'Offenbarung'', *Publications of the English Goethe Society*, 52 (1983), 90-119.

358. Worbs, Erich: 'Novalis und der schlesische Physiker Johann Wilhelm Ritter. Eine Freundschaft der Jenaer Frühromantik', in: *Aurora*, 23 (1963), 85-93.